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EXTENSION OF THE AGRICULTURAL SERVICES.

Within the past month proposals for the co-ordination and extension of the agricultural services within the Colony have been placed before the Legislature in the form of a Sessional Paper. These have also been referred for consideration and discussion by those bodies and associations connected with agriculture.

In all countries there is felt the need of scientific assistance towards agriculture, and provision is being made to meet these requirements. In Ceylon, opinions have been expressed in many quarters that greater assistance should be given to agricultural investigation and education and therefore comprehensive proposals have been submitted to the country in outline.

It is expected that these proposals may require some modifications—especially in details, and therefore the opinions of agriculturists and others interested in the economic development of the country are being sought with the object of framing a general policy. The proposals which have been prepared provide for an adequate central research establishment and divisional organizations for the investigation of local problems and for the translation of the results of research into the terms of the cultivator.

Provision for dealing with the question of pests and diseases is made and the establishment of provincial agricultural schools advocated, whilst it is suggested that agricultural officers and assistants should undertake duties in connection with the establishment, supervision and inspection of co-operative credit societies throughout the colony.

During the recent work in connection with the encouragement of the greater cultivation of food stuffs, vegetables and curry stuffs in the colony, it has been forcibly emphasized that divisional agricultural officers are essential if any considerable agricultural development is to be looked for. Districts have come to realize the assistance they can obtain from officers trained in the sciences of agriculture and requests for the services of such officers have been made.

Such trained men are at present unavailable and it is urged that steps should be taken for training these technical officers so that it may be possible to meet the demands not only of the present but also of the future. That this demand will increase in the future there is little doubt and there is little prospect of being able to meet it unless a general policy is outlined which meets with the approval and requirements of the country.

The proposals now under consideration have been framed with this object, for it is felt that a liberal policy by the State towards agricultural investigation and research is essential in a country whose interests are mainly agricultural. Investigations into old established industries are not only necessary but there are possible new industries that require to be thoroughly studied. The problems of agriculture are many and varied and no person doubts the advantage of careful and thorough scientific enquiry and investigation.

It is not expected for a moment that the proposals for a co-ordinated agricultural service can be brought into force in a day. It will be necessary to recruit some officers from abroad and to train others locally. This will take time, and therefore the scheme which has been outlined can only be brought into force as trained officers become available.

The demands of agricultural and economic investigation and research are so varied that the value of these investigations must depend to a great extent upon the training of the officers to whom they are entrusted.

A progressive policy towards agriculture in the Colony is desirable, and the co-operation of agriculturists towards framing this policy is being invited. Much has been done in Ceylon in the past in agricultural and botanical research but the threshold has barely been passed. The demands of the future will undoubtedly be greater and steps should be taken to meet these demands.

FOOD & FEEDING STUFFS.

FODDER CROPS IN BOMBAY.

"It is beginning to be recognised," says DR. H. H. MANN, "that if an animal is expected to do more than live, that is to say, if it is expected to work or to produce milk, better food than can be picked up during a large part of the year by wandering over the bare fields and stony hills of the Deccan and corresponding places in Western India or than can be furnished by rice straw or a limited amount of *Jowar kadbi* [Sorghum fodder] must be provided. An interest in the growth of purely fodder crops is therefore rising."

It must be remembered that with the excellent organization in India against famine there is no likely chance of large numbers of people actually dying of starvation as they did about 40 or 50 years ago. The danger to be now combated in long periods of drought is the loss of agricultural cattle through starvation. This has been the immediate stimulus for the growing of crops for fodder purposes. The demand for fodder in large cities and military cantonments has also helped to give this subject a new aspect and DR. MANN's bulletin on "*Fodder Crops of Western India*" is very timely in its appearance.

The situation here in Ceylon is similar only that there is not even a small fraction of the interest evinced in the subject by our paddy cultivators as is noticeable in Western India.

It has been more than once pointed out in Ceylon that the degeneration of our cattle is responsible in a large manner for the degeneration of our agriculture to which cattle form the chief source of power. It is not by complaining against the wirefencing of our grazing grounds that matters can be remedied. The evils of the open or common field system are so great that many countries have had to legislate against it. It is only by such enclosures that it was found possible to shake the people out of the deep rut of custom and make room for more progressive methods.

The future of Ceylon agriculture lies with the peasant farmers who will recognise that fodder crops should form a necessary part of crop rotation on their lands.

When this is realised and when it is recognised that bullocks or cows should be properly fed to maintain their efficiency to the proper standard then might it be said that we have taken a definite step in advancing Ceylon agriculture to a point where we can compare ourselves with Indian agriculturists.

DR. MANN's bulletin has much in it that is of interest. It is "a compilation of what has at present been found out as to be the most suitable fodder crops in Western India, the parts where each of them are likely to be useful, the methods of growing them which have given the best results, the yield which has been obtained, and the value of fodder produced." An examination of some 140 pages which comprise the bulletin show how thoroughly

the subject has been worked out, the foot-notes and references indicate an extensive search of all farm reports, journals and bulletins not merely confined to Western India nor India alone.

Before describing the crops, the features of a good fodder crop are considered, then the crops themselves are considered. These are divided according as they fall into the two large natural orders *Graminaceæ* and *Leguminoseæ*.

Andropogon sorghum and its varieties "probably stand first in being capable under a great variety of conditions of producing a very large quantity of palatable fodder in a minimum of time and under fairly dry conditions." The varieties of sorghum suitable for fodder are those that "produce thin stalks and numerous side leaves, have generally either small heads of grain or the heads of grain have the form of a graceful much branched panicle. The best grain varieties, on the other hand, have thick woody stalks which support large heads of grain with usually a curved peduncle so that the grain head droops as the grain ripens."

In the more generally moist conditions in the South of the Bombay Presidency which approximate closest to our conditions "Fulgar yellow" is described as the best variety. This grows slowly and gives about four to five tons of dry fodder on good well-tilled and well-manured land. In the Konkan coastal strip with a rainfall of about 100" two American sorghums "Amber" and "Collier" flourish as a rains crop when planted on sloping hill sides.

Where the sorghums are grown for fodder purposes the seed should be sown very thickly as much as 50 lb. per acre, with a four-coultered drill with nine inches between the drills.

The sowing of mixtures as sorghum and cowpeas or sorghum and *Dolichos biflorus* (on light soils) is advocated as the resulting fodder is much more valuable. Sorghums should not be grown continuously on the same land. They should be rotated with cowpeas or *Dolichos lab-lab*. Mustard forms a good rotation in the Central Provinces.

With regard to the poisonous character of young sorghum plants—a fact which will always place this crop at a disadvantage—DR. MANN advises that regular growth should be aimed at and that in any case the fodder should not be used till after flowering. The ratoon crop is much relished by cattle but when young is much more poisonous than the original crop.

As to the utilisation of the fodder, the usual way is to cut the crop as required and feed green to stock. It is of great importance that the material should be fed in pieces not more than 1/3rd of an inch long or else there is great wastage.

Maize stands second to jowar as a producer of fodder. Notes on this crop have already been extracted and have appeared in a previous issue of this journal. [See T. A. Vol. xlix., No. 6, pp. 369-376.—ED]

Of the millets and small dry grains the opinion is that they "have no great utility as fodder crops, and though they will always be grown in light soils, yet they are not likely to attain a very important position in Western India."

Of other grass fodder crops, *teosinte* because it needs rich soils will not enjoy much popularity. Johnson grass (*Andropogon halepensis*) is poisonous

in its early stages like sorghums and does not have many advantages over other plants. *Paspalum dilatatum* is "a very valuable grass but in no way specially suited for resisting drought." *Mauritius Water Grass* is good for damp, low-lying and water-logged places. Of *Rhodes grass* (*Chloris gayana*) "experiments made at Bangalore indicate that it has quite probably a large field in Western India." This grass is deserving of trial here in Ceylon.

Amongst leguminous fodder crops, Lucerne holds a unique place. The crop is not able to stand the heavy monsoon rains. In the Konkan it is recommended that it be sown after harvesting the rice crop in October or November. The crop will then give four or five cuttings before the setting in of the monsoon rains for the next rice crop. Berseem has a good future in Sindh and the Punjab. "Elsewhere, its value is still a matter for experiment."

Of the pulses Cowpea (*Vigna catjang*) and *Dolichos lab-lab* appear to have a very considerable future as leguminous fodder crops. Cowpea is spoken of very highly as of "exceeding high feeding value, easy to grow, and which stands ahead of all other known annual leguminous fodders for growing in the hot weather under irrigation or in the rainy season." Cuttings should take place when the pods are well formed but are still green, the proteids increase till this stage. The plants will sprout again and give a small second fodder crop. The yield when grown in the rains is about 10,000 lb. per acre.

Dolichos lab-lab grows on a stiffer soil than that on which Cowpea thrives. The seed is difficult of germination, it should be rubbed roughly and thoroughly with wet sand before sowing. The crop is cut when the beans are formed, i.e., 2½ to 3 months after sowing. The fodder is equal if not superior to cowpea.

H. L. VAN B.

GUINEA GRASS.

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A very special place among fodder grass crops must be given in Western India to guinea grass. This has proved itself of extreme value as supplying a good succulent nutritious fodder throughout the year, and its use is spreading rapidly. The peculiar advantage of this grass is that it grows well under shade, and especially so under mango trees, while a small daily supply of good green feed can be obtained without any cost by planting it on the sides of permanent water channels*.

Guinea grass (*Panicum maximum* or *Panicum jumentorum*) is a native of tropical Africa, but its cultivation has been recommended in India since 1793. The general character of the plant is well described by MOLLISON as follows:—"This perennial grass grows in tufts or hussocks many stems springing from one root. The roots are fibrous, and form a network in the soil near the surface. In countries of moderately temperate climate such as that of the plains of Northern India, the grass remains more or less

* See Leaflet No. 22 of 1909 of the Bombay Agricultural Department.

dormant in the cold weather, but flushes up again with warmth and moisture afterwards. In the hotter part of India the grass remains green throughout the year under irrigation. It may even exist without irrigation in the fair season. Such plants as survive spring up into vigorous growth when the rains come. In the monsoon and sometimes at other seasons the grass flowers and produces seed freely in India. When in full flower, the stalks are five to eight feet high, and the graceful branching panicles give the crop a very handsome appearance. During the greater part of the year, leaves are produced rather than flower stalks. The best results are obtained with copious irrigation throughout the year and with heavy applications of manure. In the warmer parts of India guinea grass grows best in the monsoon and the early part of the cold weather. It has no dead season, but gives a decidedly poorer outturn in the fair season than in the monsoon."

CLIMATE REQUIRED BY GUINEA GRASS.

The conditions under which guinea grass grows successfully seem exceedingly varied. It has been recommended and grown in almost every part of India. Outside of India it has been found valuable in nearly every tropical country, whether wet or dry. In the Philippine Islands it has given extraordinary yields* ; in the wetter regions of the United States it has been successful† and also in the drier regions of Texas.‡ It seems as if it will go on growing as long as the temperature is sufficiently high, and sufficient moisture is provided. As MOLLISON remarks (*vide supra*) in the more temperate parts of India it ceases to yield in the cold weather, though the temperature never goes below 40° to 45°F. Even at Surat, with a minimum temperature five degrees higher, its cultivation was abandoned in 1906-7 as the yield outside the monsoon season was very small, and a better fodder return was thought to be obtained by growing *jowar* in the monsoon.§ Though the abandonment there seems hardly justified, it illustrates how the yield of the plant drops when the temperature falls, in spite of irrigation.

All over Western India irrigation is required if the crop is to be grown economically and commercially. If not irrigated, it does not possess sufficient advantage for its cultivation to be recommended. In the United Provinces it has been stated not to require much water on account of its deep rooting habit‖. Our experience in Western India is, however, that it can hardly have too much.

At present its cultivation in Bombay is steadily growing. The demand on Poona for root stocks as seed is continuous, and considerable, and though its area is not separately measured or recorded, yet it is grown in every part of the Bombay Presidency, including Sind, except in the Konkan. Even in the Konkan it has been recently introduced and grows luxuriantly,¶ though sufficient evidence has not been accumulated for us to know how it will stand continuous growth there.

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*32 tons of green fodder per acre in four cuttings. JACOBSON—PHILIPPINE AGRICULTURAL REVIEW, Vol. VII (1914).

† SCOTT—Florida Agricultural Experiment Station Report, 1912.

‡ HASTINGS.—U.S. Bureau of Plant Industry, Circular No, 106 (1913).

§ Surat Agricultural Station Report, 1906-07.

‖ United Provinces Agricultural Department—Bulletin No. 6 (1897).

¶ Ratnagiri Agricultural Station Report, 1913-14.

SOILS.

Guinea grass will grow in almost any soil, provided it is not water logged. It does best perhaps on medium loam which can be irrigated to advantage, or on light deep sandy soil.* It may even be grown with advantage on land treated with town sweepings or even with nightsoil, if only it is kept free from weeds and the top surface kept soft.†

CULTIVATION, PLANTING AND TREATMENT.‡

The soil should be friable down to a considerable depth, and this condition can be obtained by two ploughings, three or four harrowings and clod crushing if necessary. Thirty cart-loads of farm yard manure should be worked into the soil during the tillage.§

The grass is propagated by seed or by division of the tussocks. The latter method is almost invariably used, and five or six root bearing stems should be planted in one place. The group of sets should be eighteen to twenty-four inches apart in each direction and the lines should be laid straight both lengthwise and across, so that interculturing may be done easily. This planting should be done on flat ground in the rains. June and July are the best months in Western India, wherever the monsoon rains occur. If the planting takes place at any other season, the field should be flooded with irrigation water immediately after planting, In the monsoon the sets can be planted during rain on light land, and soon after rain on heavier soil. When the plants have taken root, they should be ridged up (they remaining on the ridges) so that irrigation water may flow among the furrows.

If guinea grass is grown from seed, the seed should be thinly broadcasted in a well prepared seed bed. When the seedlings are well grown and have each produced three or four shoots, they should be transplanted into rows in the manner already described (MOLLISON).

After a plantation has been established, "guinea grass can hardly get too much water or manure."‖ The richer the land the more succulent and tender will the fodder be.¶ Each year at least fifteen cartloads (12,000 pounds) of farmyard manure per acre should be applied before the rains,$ or well rotted manure should be given in dressings of at least five tons per acre every fourth time the grass is cut. Few experiments in other forms of manure except with farmyard manure seems to have been made, but it has been found that guinea grass responds very quickly to well selected artificial manures, even more than to organic manures like oilcake or dried blood. In an experiment in Florida, it was found that guinea grass manured with a mixture of nitrate of soda, superhosphate and potash manure gave a yield of 3,370 pounds of cured dry hay per acre, while a similar plot manured with dried blood only gave 2,341 pounds similarly cured.℘

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* MOLLISON.—*Loc. cit.*.

† MEAGHER and WILLIAMS.—Farm Manual.

‡ We owe practically all the details of cultivation to MOLLISON. No better methods have been evolved since his time.

§ MOLLISON.—*Loc. cit.*

‖ MOLLISON.—*Loc. cit.*

¶ MEAGHER and WILLIAMS.—*Loc. cit.*

$ Leaflet No. 22 of 1909 of the Bombay Agricultural Department

℘ Florida Agricultural Experiment Station Report, 1911.

If guinea grass be grown under sewage or sewage effluent very high and sometimes extraordinary yields may be obtained. At Poona, with septic tank effluent in 1899-1900, 56,308 pounds of green fodder per acre were grown. At Karachi, under raw sewage, eight cuttings have been secured per annum with 25,000 to 30,000 pounds of green fodder per cutting, or over 200,000 pounds per annum.*

On the other hand without manure its yield rapidly declines. In Surat it has been stated that only when guinea grass obtained much manure it gave good yields; when put in fields without manure it only gave half yields†, and less than is given by a single rains crop of *jowar* fodder. The necessity of continuous and heavy manuring could not be better illustrated.

If the rainfall be normal, the crop will not require in the monsoon over the greater part of Western India, except in Sind. But as soon as the rains are over, it should be irrigated every ten or twelve days throughout the year.

Guinea grass is very apt to become over-run with weeds, and hence fairly frequent weeding is necessary. In ordinary practice here, this has usually been done by running a country plough or a country bullock hoe between the rows in both directions, and completing the operation by hand weeding where the bullock implement cannot reach. The country bullock hoe can probably hardly be improved for this purpose.

Though the grass is perennial the plantation is not and, if not dug up and replanted frequently its yield will rapidly decline, and it is usually necessary to re-establish it after three years. The same land can usually be used again, but the tussocks of grass become over-grown and form big stumps with many dead shoots in them. The roots become thickly matted together, and digging out is essential. The way this replanting should be carried out is as follows. New sets should in the first instance be chopped off the old tussocks and planted in the furrows at the required distance apart, and when these are established the old tussocks should be removed. This makes it possible for the new plants to be almost in full vigour before the old ones are taken away.

One method of planting, which has been already referred to, is that along the sides of irrigation channels. Here the guinea grass serves a very useful and profitable purpose. It is the usual custom to leave the sides of irrigation channels to the care of nature. Abundance of weeds and grasses grow along them, and sometimes even spread into the channels and partially block them. Moreover many weed seeds are scattered on the irrigated land adjoining. If, however, guinea grass sets are planted in this position, the sets being placed twenty-four inches apart, the grass grows very well indeed and smothers the weeds, besides protecting the sides of the channel from erosion. It also produces a considerable amount of good fodder from an

* KELKAR.—Bulletin No. 34 (1909) Bombay Agricultural Department.
† Surat Agricultural Experiment Station Report, 1906-07.

area usually almost entirely wasted. The amount of profit thus obtained is indicated by experience on the Agricultural College Farm, Poona, in 1913-14, where from 2,596 feet of water channels, with guinea grass on both sides, 9,272 pounds of green guinea grass fodder were produced, which at 150 pounds per rupee was worth Rs. 62.* This is obtained without any special expenditure and the fodder is available in some quantity throughout the year.

The crop has so far, in Western India, been free from disease, and the remark of MOLLISON to this effect can be confirmed after fourteen years' further experience. Smut occasionally attacks the ears, but when the plant is grown for fodder this is not a matter of importance.

REAPING THE CROP.

The first cutting of guinea grass can be obtained in three months after planting the sets. When first cut it should be three or four feet high as, if it is allowed to grow more than this, it becomes very coarse. This is also the case when the flower stalks are allowed to form. The leaves and stalks under these conditions become very fibrous and are not liked either by cattle or horses.

Subsequent crops should be cut at a height of two to three feet, as the oftener it is cut, the finer will be the fodder, and the larger the outturn. In Poona it is the custom to take cuttings about every six or seven weeks when the plantation is established, or about nine or ten in a year, but in some parts of India, as many as twelve cuttings have been obtained annually.

In reaping guinea grass it is very important to cut it as close to the ground as possible. If this is not done the stubble remains as dead matter in the grass tuft, and prevents the further cutting of the grass as low as might be desired, as well as tends to check the growth.

Yield of the Crop.—The yield of guinea grass obtainable seems to vary very much, but the highest on record seem to have been obtained under sewage at Karachi as already stated, namely, over 200,000 pounds (green) per annum. Apart from this the highest on record are in Northern India. MEAGHER and WILLIAMS state that they have obtained 1,500, maunds or 120,000 pounds (53½ tons) of green fodder per acre in twelve cuttings† This is an extraordinary amount and far in excess of any other record I have seen except that quoted from Karachi. Thirty-two tons per acre have, however, been obtained in the Philippines, and this in four cuttings.‡ Under ordinary circumstances in India, however, it yields between thirty and forty thousand pounds of green fodder per acre as a maximum and the yield of a plantation even when renewed frequently tends to fall to half this amount. At Pusa§ in 1911-12 the maximum yield quoted was 28,700 pounds per acre.

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* Agricultural College Farm Report, Poona, 1913-14.

† Farm Manual.

‡ JACOBSON.—PHILIPPINE AGRICULTURAL REVIEW, Vol. 7 (1914).

§ MILLIGAN.—Report, Imperial Agriculturist, 1911-12,

In Bombay the yield has been exceedingly variable MOLLISON considers from 20,000 to 35,000 pounds per acre as normal yields with eight cuttings but the actual records from various centres in Western India are as follows :—

POONA.

Year	Yield per acre	Cost per acre	Value of crop per acre	Number of cuttings
	lb.	Rs.	Rs.	
1893	35,028	110*	233	10
1894	21,295	82	106	10
1896	19,167	49	96	No record
1897	16,106	73	80	,,
1898	15.493	53	77	,,
1899	13,552	67	68	,,
1900	17,103	61	114	,,
1902	13,662	60	91	,,
1903	12,252	No record	(Profit Rs. 46)	,,
1904	12,551	49	84	4
1905	12,569	34	89	No record
1906	15,566	42	78	,,

These records of yield in Poona tell of the very large yields which may be obtained, They tell also how essential it is for a plantation to get full attention and to be fully renewed. In the present instance this renewal was not attended to, for in 1904 it was noted that "the plantation is old and needs renewal." The result was a decline in yield, and a reduction in the number of cuttings. During the years from 1893 to 1900 the average yield was 19,700 pounds or 8·8 tons of green fodder per acre—equivalent to slightly under four tons of dry fodder per acre. The average annual yield is thus a little below what would be expected for a single crop of *sundhia* fodder, though of course, the crops cannot be compared purely on a basis of yield. In the following years (1902-1905) when the plantation was confessedly old and needed renewal, the average yield was only 12,750 or 5¾ tons of green fodder, equivalent to 2½ tons of dry fodder per acre. The yield of an old plantation may go down as low as 4,100 pounds of green fodder per acre. The urgent necessity of the frequent renewal of a guinea grass plantation could not be better illustrated than by these figures, especially as they are confirmed by experience at Surat to be given later.

When a guinea grass plantation is commenced at the beginning of June, the yield in the first year is small, that at Poona, for instance, in 1906-07 yielding 4,323 pounds of green fodder per acre before the following March.†

* The extra cost in these years is due to manuring being done in these years only, in the years before 1900.

† Poona Dairy Farm Report, 1908-09.

SURAT.

At Surat, on somewhat deep black soil, and with a rather brackish irrigation water our experience has not been as long as at Poona, but the results are as follows :—

Year	Yield per acre	Cost per acre	Value per acre
	lb.	Rs.	Rs.
1898–99	28,580	172	190
1899–1900	29,549	116	197
1900–01	42,594	170	213
1901–02	22,802	No record	114
1902–03	29,341	175	147
1903–04	25,835	176	172
1904–05	13,972	167	93
1905–06	18,613	194	124
1906–07	13,484	113	90

Here we get a clear illustration of the deterioration of a plantation which does not receive frequent renewal and full quantities of manure. In 1903 the plantation was reported to be choked with dry stumps, and thereafter it deteriorated rapidly, till in 1907 it was abandoned as unprofitable.

It was however planted again in 1912, and yielded, in heavy soil, 17,274 and 15,869 pounds per acre of green fodder in two successive years.

Experience elsewhere in Western India where records are obtainable has been shorter, but may be indicated as a guide in the various districts. At Dhulia* (West Khandesh) guinea grass planted under trees gave 11,000 pounds of green fodder per acre in the year of planting—an exceedingly good result—and 30,620 pounds in the following year. This is in one of the typical black soil districts of the Deccan.

On light sandy land at Gokak† it was equally successful, and gave six cuttings in the first year and the same number in the second. This took place in spite of the land being somewhat salt (*karal*), and the soil having to be mixed with nala-silt before it would grow any crop. At Ratnagiri,‡ as already stated, where the rainfall is much heavier, it has been exceedingly luxuriant during the last two years, though it is still a question whether it will stand the heavy rainfall of the monsoon there. In Sind§ it is very successful indeed.

As far as our experience goes, in fact, there seems no part of Western India in which guinea grass will not grow and grow luxuriantly, and for its own purposes, it is one of our most valuable fodder resources.

FEEDING VALUE.

Except when allowed to go to seed, guinea grass makes an exceedingly valuable and nutritious fodder. Analyses by LEATHER¶ have given the following results. The first two samples given were obtained from Poona and analysed in the fresh condition ; the third is an average of many

* Report, Dhulia Agricultural Station, 1912-13.

† Report, Gokak Agricultural Station, 1912-13 and 1913-14.

‡ Report, Ratnagiri Agricultural Station, 1913-14.

§ Report, Mirpurkhas Agricultural Station, 1913-14.

¶ LEATHER.—Agricultural Ledger No. 10 of 1901 and No. 7 of 1903.

examinations of the dried grass, and the analysis is given on a basis of ten per cent. of water.

	1 fresh grass (Poona)	2 fresh grass (Poona)	3 Dried grass (Average)
	p. c.	p.c.	p.c.
Water	63·4	71·5	10·0
Ether Extract (oil, etc) ...	0·8	1·0	2·6
‖Albuminoids (proteid nitrogen × 6¼)	1·9	2·6	6·2
Soluble carbohydrates ...	19·4	13·7	45·8
Fibre	8·8	5·7	20·1
Ash	5·7	5·3	15·4
Total ...	100·0	100·0	100·0
‖Total nitrogen	0·41	·53	1·3
Proteid nitrogen	0·30	·42	1·0

It is thus an exceedingly fine fodder for all descriptions of farm animals, and experience in Western India has confirmed the result of analysis. For horses it has been used for many years on the military grass farms and remount depôts. "At the remount farm, Ahmednagar, the young horse stock are regularly fed with it. The daily ration increases with age, twenty-five pounds chaffed with dry food being the daily allowance."* It is very much liked by horses of all ages. For dairy cattle it is equally good†, and has been fed to them for many years at Poona with success. The same has been the case elsewhere, and in Porto Rico it is stated that "it is best adapted as a pasture for cows, the fat content averaging considerably higher for cows so fed." It can be fed up to forty pounds per day per head to dairy cattle with advantage.‡ For working cattle it is regularly used in many parts of the country, and at Saidapet it was used for ewes and lambs with success.

In India the crop has been hitherto almost entirely cut and fed green. At Saidapet a well established plantation was however grazed with success, and abroad this is often done. But it must not be grazed too closely, or it will not recover quickly. The principal advantage as a fodder is that it secures a supply of green fodder during the dry parts of the year from areas which would otherwise be largely waste (such as places under shade, or the banks of irrigation channels), and at this time the green soiling system is by far the most applicable.

During the rains, however, when there is abundance of green fodder, and when it grows luxuriantly it can be used to make very good silage, and for this purpose it is as good as any grass we have. After the rains are over, say from the third or fourth cutting from the commencement of the season in June, it can be made into fairly good hay without any difficulty, provided the weather is favourable. As the season proceeds, there is less and less danger of any difficulty through rain, and several crops of hay may easily be obtained if the grass is not needed as green fodder.—DEPARTMENT OF AGRICULTURE, BOMBAY BULLETIN No. 77 OF 1916.

* MOLLISON.—*Loc. cit.*

† "For young horse stock and dairy cattle it cannot be surpassed."—(MOLLISON)

‡ LUCAS.—JOURNAL, Indust, and Engin. Chem.. Vol. VI (1914).

DRY GRAINS IN THE MADRAS PRESIDENCY.

Methods of cultivation, rotation, etc.—Good crops of dry cholam were obtained at Coimbatore, one field giving 1,318 lb. of grain and 6,800 lb. of straw per acre. A new experiment was made in cultivating cholam in lines 3 feet and 4 feet apart in order to enable weeds to be thoroughly eradicated by continued working of hoes between the lines. Five hoeings were given at a cost of 6 annas per acre and excellent yields of over 1,000 lb. per acre obtained. This method will be thoroughly tried, as it shows how it is possible to eradicate weeds without sacrificing anything of the yield. Similar wide spacing and hoeing of red gram was tried and is recommended for keeping down weeds. Measurements of the water needed by irrigated cholam grown in the hot weather showed that some 18 inches were required. Similar measurements were made for ragi. Many other dry crops were grown, including a small area of soya beans received from Madanapalle. This did well and will be tried more extensively together with a further consignment of seed which has been obtained from China. The rotation experiments with cereals and Bengal gram which have been in progress at Hagari since 1906 will be discontinued and experiments with groundnut as the leguminous member of the rotation substituted, since groundnut is now becoming an important crop on the black soils of this area. The experiment on the relative merits of planting irrigated ragi in beds or on ridges again gave inconclusive results, the slightly increased yield of the bed method being counter-balanced by the increased cost. This experiment will therefore be discontinued. The rotation experiments at Nandyal were continued. As at Hagari groundnut will be substituted for Bengal gram in future. An experiment on spacing cholam at Nandyal showed that rows 14 inches apart gave better yields than the local practice of drilling rows 9 inches apart. It is possible that wider spacing still will give even better yields and this point will be tested.

Manurial.—The permanent manurial experiments on dry crops at Coimbatore were continued, three more crops being taken. The results up to date, which indicate phosphorous starvation in all the plots which have not received this ingredient, were summarised in the Year Book. The experiments on the application of cattle and sheep manures at Hagari and Nandyal were continued. The use of oil-cake on these black soils does not appear to give results sufficient to cover the cost of application even when the cake is previously rotted before application so as to make it available quickly.

Seed selection and varieties—Sorghum (cholam).—At Hagari five single plant selections were tried again, and their yield compared with that of ordinary bazaar seed. The yields were better all round than in last year so that differences were not so well marked. Some of the selections were distinctly promising. Six selected strains were similarly tried at Nandyal. At Hagari a number of varieties from different parts of the Presidency are being grown to provide material for further selection.

Ragi, cumbu, etc.—Five selected strains of ragi were grown at Hagari for comparison with each other. The Belgian Congo cumbu when tried at Coimbatore grew well, but ripened very unevenly and displayed great variations. Seed selection work on this is being carried out by the senior students

This is also being grown at Koilpatti where it did well, as also a strain of cholam from the same locality which yielded very well and gave a good ratoon crop. Strain No. 9 of Italian millet gave good results at Coimbatore, over 1,100 lb. to the acre. There is room for much more work on selecting improved strains of these dry grain crops, but it is difficult for our limited staff of agricultural officers to find time for it.—REPORT ON THE OPERATIONS OF THE DEPT. OF AGRIC., MADRAS PRESIDENCY, 1916-17.

THE PRINCIPAL FORAGE CROPS OF THE PHILIPPINES.

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Other than the native "zacates" (grasses), which are the sole forage crops in some localities, the following crops are the principal forages of the Islands. Although some of the crops enumerated below are not as yet widely diffused throughout the Archipelago, yet there is every possibility that they will be so diffused in the course of a very few years, since the carabao and hardy native ponies subsist almost entirely on forage, and receive little or no grain food. Hence, there is every likelihood that any crop of a forage nature that is well adapted to the diverse conditions of the Islands will receive consideration from both native and foreign farmers.

GUINEA GRASS (*Panicum maximum*).

Guinea grass, a native of tropical Africa, is cultivated at the present time for forage purposes, throughout practically the whole of the tropics. Its introduction into the Philippine Islands dates from 1907, when 20 root clumps of a shipment from the Hawaiian Experiment Station, to the Philippine Bureau of Agriculture, arrived in Manila in good condition. In 1909, these 20 roots had furnished sixty-one thousand plants for distribution, and early in 1914, the Bureau of Agriculture had distributed to different concerns and private individuals throughout the Islands, some hundreds of thousands of root bunches, each bunch containing from twelve to twenty-five stems. This tremendous increase was made possible by a process of divisioning and replanting every few months. It is estimated at the present time, 1917, that the twenty root clumps received in 1907, are now the parents of some millions of plants, distributed throughout the Archipelago, mostly to large estates, where the crop enjoys high favour as a forage for horses and cattle.

Under Philippine conditions Guinea grass grows best where plenty of water is available for irrigation purposes during the dry season. The grass readily responds to almost any kind of organic nitrogenous fertiliser, and when well watered and fertilised, produces green forage 2 to 2·5 metres high, and to the amount of about 50 metric tons per hectare per cutting. It can be cut approximately five times each year without fertilization and proper irrigation, however, production is between 15 to 20 tons of green feed per hectare per cutting, and thus drops from its higher level of production to that of the native "zacates."

Guinea grass grows well in most Philippine soils, but prefers the open well-drained sandy loams found in the valleys to that of the heavier types.

To get the maximum yield, with the methods of culture practised in the islands, it is necessary to dig up the roots and replant them to a new field every two, or not more than four years, this sort of procedure is a very simple operation and is practised where the crop is cultivated on an intensive basis.

The method of planting employed throughout the Islands is the row system, that is, the rows are planted 1 metre apart, and the plants are set one-half metre apart in the row, giving a stand of 20,000 plants per hectare; this applies to that planted for forage purposes, but that planted for pasturage is set 60 to 80 centimetres apart, and the plants are set about three to four per metre in the row.

The analyses of the green plant as compared with other Philippine-grown grasses, is as given in the following table :—

	Balili zacate	Barit	Guinea grass	Manimanihan
	Per cent	*Per cent*	*Per cent*	*Per cent*
Water	85·56	68·84	77·85	67·39
Ash	2·19	6·64	2·85	3·69
Protein	2·96	2·76	3·34	4·28
Carbohydrates	6·71	11·88	8.09	7·86
Fat	·90	1·51	·57	8·09
Fibre	4·68	8·37	7·30	8·69

UBA (JAPANESE FORAGE CANE) *Saccharum sp.*

This is probably the most popular forage crop in the Philippines, because the Filipino farmer is more familiar with its planting than he is with the planting of any other forage crop. This familiarity with the planting methods is due to its similarity to sugar cane, large quantities of which are planted yearly, over nearly the whole of the Islands.

Uba cane is planted from points. These are set in rows 75 centimetres apart and three points per metre in the row. It thus requires about 40,000 points to plant one hectare. This cane when allowed to obtain its full growth reaches the height of 1½ to 3 metres, and can be cut several times per annum, as it ratoons almost indefinitely. Twenty tons of green fodder per hectare is considered a very moderate crop. Uba, like any other cane variety requires a considerable amount of water during the dry weather for its best production. Consequently, in very dry sections where irrigation water is not obtainable, Uba is to be avoided and some of the more drought-resistant crops selected.

SUDAN GRASS (*Holcus sudanensis*).

This remarkable forage plant, under Philippine conditions, grows to the height of 2 to 3 metres, and matures the first crop within three months from the time of planting.

The seed is sown in rows 75 centimetres to 1 metre apart, or is broadcasted upon well-prepared ground. Two kilos of seed are usually considered sufficient to plant 1 hectare, when planted in rows ; broadcasting requires from three to four times this amount of seed. This grass grows very rank but stands up well for its extreme length. From three to five crops may be expected yearly, depending upon the local environment. The seed is usually planted just before the beginning of the rainy period so as to obtain the

impetus of growth from the heavy rains. Sudan grass is perennial in the Philippines if not allowed to seed, and one planting is good for two or more years.

Sudan grass as compared with Guinea grass is equal in yield, but has the added advantage of requiring less water. The forage or hay is slightly coarse; however, if pastured or cut before the seed forms it is quite palatable to stock. It makes a good soiling crop for native cattle and carabao.

DESERT INDIAN MAIZE (*Zea mays*, varieties).

During the latter part of 1914, three varieties of Indian corn obtained originally by the United States Department of Agriculture from the Pueblo Indian reservation, United States of America, were introduced into the Islands, and in 1917, six more varieties were received by the Bureau from the same source. This corn in its native habitat is capable of reaching the surface when planted to the depth of 32 centimetres (COLLINS' JOURNAL OF HEREDITY, 1914), so there is not much danger of it not coming through when planted to a good depth sufficient to obtain moisture for germination during dry weather. It is purely a dry weather crop, and such it should be considered, as it grows luxuriantly under Philippine drought conditions, but fails almost entirely when planted during the wet weather.

This type of corn has the same colouration as those varieties in the United States known as "Squaw corn," that is, the kernels are of purple, blue, yellow, white, and red colours. The starchy portion of the kernels is somewhat powdery and the cuticle is fairly loose, but with due precautions the seed can be preserved from weevil attacks. The ears are short, averaging about 5 to 6 inches in length, but are of fair circumference.

This corn produces exceedingly well and reaches maturity in from sixty to eighty days from the time of planting. All these varieties are dwarfish in character, averaging less than 90 centimetres in height, and having a small stalk densely covered with foliage, sucker abundantly and develop to the roasting-ear stage within forty to fifty days from the time of planting.

For forage purposes, they are planted in rows 75 centimetres apart, 15 centimetres apart in the row, and are cut at a little past the roasting-ear stage. Eighteen liters of seed is considered sufficient to plant 1 hectare and at this rate of seeding 2 to 5 tons of dry feed can be expected from one hectare. No irrigation is necessary to start germination provided the seeds are planted in moist soil, and this can usually be obtained in well cultivated land at a depth of from 10 to 15 centimetres. A crop of about 3,750 liters of seed per hectare is obtained when left to mature.

PEANUTS (*Arachis hypogea*).

The Philippines have the necessary requirements for a peanut country, namely, a long growing season without frost, a high temperature, a sandy soil, and a dry season for harvesting the crop.

In the Philippine Islands, peanuts are planted so that they will ripen before or after the rainy season. If they mature during the rainy weather it is hard to handle the crop, and unless they are harvested immediately after ripening, they soon decay, or burst open and start to germinate. There are several varieties of peanuts that are grown in the Philippine Islands, the following being the most important: The Virginia runner, North Carolina, Virginia bunch, Improved Valencia aud the Spanish (introduced from the

United States), the large-India, large native, Pondicherry-India, Japan-India and the Spanish-India. The names suggest the source of introduction and origin. Of these several varieties, the Pondicherry, the Spanish, the Virginia varieties, and the large native are perhaps the best known and the most widely grown.

Although in these Islands peanuts are not put to the many uses that are made of them in other countries, yet their rate of consumption is rapidly on the increase. During 1914, besides the amount produced in the Islands, $80,633 worth of peanuts were imported, most of which came from the neighbouring coast of China. The above figure does not include those imported in the form of peanut butter, oil, etc.

Under Philippine conditions the Spanish peanut matures in from four to five months, while it requires from six to eight months for the large varieties to mature. When planted in rows from 60 centimetres to 1 metre apart 3,750 to 4,000 liters of unshelled peanuts per hectare can be expected, depending of course upon variety, season, etc.

Aside from the many varied uses of the nuts themselves the entire peanut plant is valuable both as a hay and forage crop.

The tops of the peanut plant when cut and cured in the same manner as cowpeas produce a very palatable hay which is almost equal in feeding value to some of the best hay plants of the Temperate Zone, for instance clover and alfalfa hay.

By planting the Spanish peanut in rows from 60 to 70 centimetres apart and quite closely in the row and giving the crop two or three cultivations, a yield of from 3 to 5 tons per hectare may be reasonably expected. After the hay is removed the pods can be turned out by means of a plough, cured, and stored for subsequent feeding, or hogs may be turned in to gather the crop.

Where the entire peanut plant is to be stored and used as a forage for feeding to stock the work of curing and caring for the vines is very much the same as in curing cowpea hay, although the peanut vines will cure more rapidly than those of the cowpea.

The vines may be ploughed from the soil or pulled up by labourers, and after being allowed to lie exposed for a few hours are gathered together in windrows. After partially drying in the windrows the vines are put up in small shocks. The main object in handling peanut vines for forage is to properly cure the stems and nuts without losing the leaves, and in order to do this it is necessary to keep them in bunches and to dry them gradually. After the vines are dry they may be either stacked in the field or hauled to a shed and stored.

It for any reason it may be undesirable or impracticable to make peanut hay or forage a convenient method of harvesting both vines and nuts is by pasturing the crop to hogs, cattle or carabaos.

Although the peanut is not a new crop in the Philippine Islands, its chance for future development as a stable crop may nevertheless be considered as one of the agricultural possibilities of the Islands, as its usage is becoming more common each year.

COWPEAS *(Vigna unguiculata).*

Cowpea varieties have been introduced into the Philippine Islands by the Bureau of Agriculture, with more or less success, for a period of several years. The greatest find along this particular line, however, has been the New Era, which has proved to have no rival for abundant growth and sound seed production, either from tropic or temperate-grown seed of other varieties, when subjected to Philippine conditions.

New Era cowpeas, as grown by the Bureau of Agriculture, have proved to be the best cover crop obtainable, for planting in such locations as banana plantations, papaya orchards, etc. Not only have they proved good nitrogen restorers, but they have aided materially in the killing of weeds, thus greatly reducing expenses for the upkeep of such plantations.

If such plantations as mentioned above are planted to cowpeas during rainy season and if weeds are not too abundant, the broadcast method of planting is advisable, for usually sufficient water is available at this time to carry the crop through without injury to the other plants. However, when planted during the dry season, or when weeds are prevalent, the row method is employed and during the worst drought it is advisable to irrigate to insure a crop, and to prevent injury to the other plants. Where the row method is used, the rows are made 75 centimetres apart and seeded at the rate of five to six seeds to the one-half metre, but where the broadcast method is deemed advisable, the seeds are sown so as to allow 15 to 20 square centimetres for each fertile seed. Thus, if the seed is poor, thick planting is necessary.

On rich soils or on soils that have grown some other legume previously, these distances are increased. From 60 to 120 liters of seed are used to plant 1 hectare, depending upon whether the broadcast or row method is used.

The value of New Era cowpeas as a cover crop for banana orchards, etc., under conditions as mentioned above, is due to the fact that the vine runners are not of sufficient length to climb the banana or papaya stalks for any considerable distance, thus eliminating the possibility of injury from climbing vines, which often occurs where running plants like the stizolobium are used.

As a catch crop, the New Era cowpea has proved to be at its best, as it requires only a short time, three to four months, for the crop to mature. In this length of time it has been known to store up 100 kilos or more of nitrogen to the hectare. Besides its value as a nitrogen gatherer, the forage that can be harvested from the New Era cowpea is a considerable item, and in a country like the Philippine Islands where alfalfa and clover do not grow, the hay thus obtained proves valuable as a food for animals.

The vines at any time are excellent forage, especially if partly dried. If cut just before maturity, from 3 to 7 tons of dry forage per hectare can be expected.

Cowpeas grow well during both the wet and dry seasons, but for haying purposes, planting is done during the latter part of the wet season so the crop can be cut during the dry weather.

As green manure and soiling crops, the cowpeas are very useful, as they grow prone upon the ground which makes them comparatively easy to plough

under, especially for the small-type one-handled ploughs so common in the Philippines, while their low-growing, luxuriant growth has proved a tempting food for native hogs, sheep, chickens, and goats.

The young beans when fresh and green are similar to the garden bean as a vegetable food, and by some people are thought to be far superior, as the cowpeas at such a time have an exceptional flavour; they are used throughout almost the whole of the Islands for much the same purpose as green beans are used in America.

NON-SACCHARINE SORGHUMS (*Holcus* species).

This group is composed of the kafirs, sorghums, milos, feterita, etc., and is particularly well adapted to a dry climate, such as the dry season of the Philippines.

The following plants were introduced into the Islands by the Bureau of Agriculture in 1915, the seeds being obtained direct from the United States Department of Agriculture: Black-hulled white kafir, pink kafir, red kafir, feterita, doura, orange sorghum, Minnesota amber sorghum, gooseneck sorghum, dwarf negari, honey sorghum, sumac sorghum, and dwarf milo.

These plants grew rapidly when planted and were admirably adapted to their new environment, producing all the way from $8\frac{1}{2}$ up to $32\frac{3}{4}$ metric tons of green forage per hectare. The planting methods employed are the same as those used in the United States, namely, sown thickly in rows from 90 centimetres to 1 meter apart. The following is the calculated production of green forage per hectare as taken from the experimental data: White kafir, 12·2 tons; red kafir, 12·6 tons; orange sorghum, 17·2 tons; feterita, 12·25 tons, pink kafir, 9·5 tons; Minnesota amber sorghum, 18·25; goose neck, 8·5 tons; dwarf milo, 13·5; honey sorghum, 25·5; sumac sorghum, 32·75; dwarf milo, 13·5; and black-hulled white kafir, 17 tons. It will be observed that the "sorghum" produced approximately twice the amount of green forage that the kafirs and the milo did, and this is to be expected because of the normal ranker growth of the sorghums in favourable environments. All the plants produced exceedingly well, both in Manila and Occidental Negros, maturing in from sixty to ninety days from the time of planting. A small amount of the seed has been distributed by the Bureau of Agriculture to different people, but there seems to be no great demand for the seed at present, because of the abundance of other forages that have already received a somewhat permanent foothold, in districts where forage is needed. Regardless of this fact, however, there is doubtless a great future in the Philippine Islands for the non-saccharine sorghums as a dry-season forage, as they are well adapted to the climate, produce well, and are suitable feed for native stock.

MUNGO (*Phaseolus radiatus*).

Mungo is a plant indigenous to the Old World, more probably to India, but is now quite generally cultivated throughout the Tropics. The plant is widely disseminated throughout the Philippines and has been cultivated for

ages, but can scarcely be said to appear as spontaneous. The seed of mungos are of a variety of colours, those of the Philippines being yellow, black, and green, or a mixture of all three colours. Of these three varieties the green is far more popular than the others and is to be found under cultivation in practically every province of the Archipelago.

Three native varieties of mungo, one green seeded, one black seeded and one yellow seeded, were tested out by the Bureau of Agriculture at the Lamao station ; all three varieties gave good results producing from one-half to three-fourths of a metric ton of seed per hectare. One red variety introduced from Japan was also given a trial but failed to become properly acclimated, and had to be discarded. The mungo is used at the present time by up-to-date rice growers as a soil renovator, after the rice crop has been harvested, and it has proved quite successful for this purpose.

Mungo hay is somewhat similar to cowpea hay, and is harvested, gathered, and stored in the same way. The green plant is considered a good soiling crop for all kinds of live stock, more especially for hogs and chickens.

The mungo is one of the most popular legumes in the Philippines and is rightly so, because it is second to none as a green-manure cover, and hay crop, when grown under the proper conditions.

FIELD CORN (*Zea mays*).

The two principal varieties of corn in the Philippine Islands are the "Moro white," and "Calamba yellow," both of which are perhaps as well adapted to the diverse conditions of the Islands as any varieties that could be found. There are several other varieties that receive recognition, such as Lobo yellow, Cagayan yellow, etc., but they are not so widely distributed as the first two.

The ear length of these two varieties is considerably less than that of the average ear from the corn-belt states of America. The kernels are shallow and the ears lack cylindricalness, usually tapering uniformly, but to an extreme degree. The ears of the yellow variety somewhat resemble the northern type of the American corn, being small, flinty or resinous, and having a more pop-corn appearance than the white variety, which is larger and more cylindrical, but has larger cobs and a less compact type of ear.

The cuticle of the kernel of both varieties is hard and horny like, a characteristic very suitable to Philippine conditions, as such a condition of the cuticle is necessary to prevent wholesale consumption by weevils, "the bane of all Philippine seed growers."

The name "white Moro" is a misnomer, since the corn is a stable hybrid between Mexican June, a variety of American white corn, and a native variety, and has nothing to do with Mindanao (Moroland), except that it is grown there as a field crop. The so-called "white Moro" variety is a very productive corn, enjoying the greatest popularity and is used quite extensively as human food throughout the Islands. Sweet corn attracts ants

so readily when planted that it cannot be grown successfully for roasting-ear purposes, unless great care is taken to preserve the seed from attack. Consequently, both white and yellow field corn are used for this purpose, but the white variety is generally preferred.

Corn is usually planted in the Philippines immediately at the end of, or sometimes after the end of the rainy season; that is, in such parts of the Islands as have a well defined rainy period.

Growing as it does only after the rainy season, corn has a certain amount of dry growing weather to endure, the amount of such weather of course depending upon whether planted in the early or late season. Due to the dry condition prevailing at this time, corn is given more space than it would be given were it planted in a more favourable environment. The planting distance is 1 meter between hills. Where the rainfall is evenly distributed throughout the year the corn is planted somewhat closer, the average distance being about 90 centimetres, and about three stalks per metre in the row. The yield per hectare under nominally good cultivation is from 3,600 to 4,800 liters of shelled corn per hectare. However, yields of 8,250 liters of shelled corn per hectare have been realized in the Calamba, Laguna, district.

Although field corn is not much used as a forage except in a few localities where the live stock industry has taken a hold, yet its potential possibilities as such will be of great value as the live-stock industry of the country develops, since it is already widely diffused throughout the Islands. Corn is cherished as a human food in all islands of the Archipelago, but more particularly in the southern, or Visayan group,

No one knows the exact date, or place from which corn was first introduced into the Philippines; some hold out for China as the source of introduction, but the greater consensus of opinion is unanimous in the belief that it was introduced from America by the early Spaniards. At any rate it is almost ancient cultivation since it is to be found growing under cultivation in out-of-the-way places, where the residents insist it has been cultivated for generations.

The use of corn leaves for fodder, while not generally practised here, is nevertheless, to be recommended. As soon as the ears reach the stage of maturity when no milk can be pressed out of the grains, the fodder is ready for pulling. Pulling the leaves at this time will not materially reduce the yield of corn. Only green blades should be pulled.

The leaves are tied in small bundles and hung over the ear which remains on the stalk. The bundles are allowed to cure in the sun for a day or two, then collected and stacked in the field. When thoroughly cured the fodder may be restored under sheds in bulk and will keep for quite a long time. Corn leaves saved in this manner make a hay which is palatable feed for stock and which is an acceptable substitute for the more nutritive hays.

—THE PHILIPPINE AGRICULTURAL REVIEW, VOL. x., NO. 3.

LEUCÆNA GLAUCA.

(Leaflet No. 7, Department of Agriculture, Ceylon).

There have been numerous requests during the past few months for information in regard to *Leucœna glauca*, its value as a green manure and as fuel.

This plant is a small leguminous tree, native of Tropical America, at present to be found acclimatized in many parts of the low-country of Ceylon. It is common in Java, up to 4,000 feet where it is used as shade for coffee

LEUCÆNA GLAUCA.

and for fuel, and is abundant throughout the whole of the low-country of Mauritius, Reunion, and many parts of Madagascar, being used for fuel and fodder. In the Philippines also it appears to have spread within recent years and is reported as being then used for planting in wild grass lands and as light shade for forest plantations.

Leucœna glauca has been used for some years on the Experiment tation, Peradeniya, as a green manure for rubber, and has been regularly

cut 4-5 times a year with the object of adding humus to the soil. The average quantity of green material per acre per year has been found to be: first year after planting 29,000 lb., second year 77,000 lb. (5 cuttings), and third year 91,900 lb. (6 cuttings). Under these conditions it is kept at an average height of 2 ft. In Java it is likewise used as a green manure plant. It is commonly employed in young coffee and rubber plantations up to 3,500 feet, and has been experimented within tea. It is lopped every 3-5 months, and gives a fair quantity of green mulch per acre.

As a green manure in young rubber it was found to be sometimes rather difficult to establish, but when a good cover had been obtained it has stood frequent cutting well, and does not appear to suffer from spells of dry weather.

It is used in Java as a light shade for Robusta coffee and is being similarly employed at the Peradeniya Experiment Station. It seems to be well suited for this crop. These shade trees are allowed to grow to about 10 feet in height, and they are lopped twice a year, the loppings being mulched around the coffee trees.

In Mauritius, where the plant grows wild over extensive areas of land it is coppiced regularly every year or every alternate year for fuel. The individual stems of the plants cut have a diameter of between 2-3 inches and its use as fuel is mainly confined to suction gas plants and to household purposes. Under Mauritian conditions trees left for years uncut rarely attain a diameter of more than 4-8 inches, or a height of more than 15-18 ft. In Java the trees grow up to a height of up to 24 feet. The plant in Mauritius is found mainly in the dry zone, with an average rainfall of 50-60 inches of rain, and is encouraged as a light shade in aloe fibre plantations. In the neighbouring island of Rodriguez large tracts of Crown land are covered with *Leucæna glauca*. Fuel is cut from these lands for household purposes, while the leaves are collected for feeding cattle and goats, and the dry seed for export to Mauritius, where they are greatly appreciated as food for cattle.

Cattle are very fond of the leaves of *Leucæna glauca*, and in some places herds of goats are housed and fed solely upon leaves of this plant with the object of producing manure. The leaves are rich in nitrogen and potash salts, as the following analysis shows:—

	Per cent.
Ash	9·26
Nitrogen	2·52
Potash	2·38
Phosphoric acid	0·45

The seeds are also a valuable food, rich in nitrogen, and may be fed to cattle, sheep, or goats. It should, however, not be fed to horses, as it causes an irritation of the skin, with subsequent loss of hair from the mane and tail, and sometimes coat.

Analysis of the seed give the following average results:—

	Ceylon By Agricultural Chemist Per cent.	Mauritius By P. BONAME Per cent.
Water ...	4·50	9·59
Ash ...	4·55	3·69
Woody fibre ..	14·50	14·00
Fats ...	6·40	4·84
Non-nitrogenous matter	40·11	38·24
Nitrogenous matter	29·94	29·64
	100·00	100·00
Nitrogen ...	4·79	4·74

The outer coat of the seed is very tough, and accounts for 50 per cent. of its weight.

Laboratory tests were made by BONAME in Mauritius in 1897, where he separated the seed from the seed coat and then analysed them. The results were as follows:—

	Meal from inner part of seed. Per cent.	Husk. Per cent.
Water ...	11·44	12·58
Ash ...	4·78	3·42
Woody fibre ...	7·80	13·90
Non-nitrogenous matter	37·09	55·03
Nitrogenous matter ...	31·87	11·87
	100·00	100·00

On account of this hard seed coat, it is usual in practice either to boil the seed until the seed coats burst or to crush the seed dry in an ordinary seed crusher. The latter practice is generally recognized in Mauritius as being the more satisfactory, and is in agreement with the general practice of feeding cattle with dry food rather than with mashes or slops. In the Philippines it is recorded that *Leucæna glauca* has been successfully used by forest officers against illuk *(Imperata arundinacea)* for it is quick growing and eventually shades the illuk sufficiently to effectively kill it out. It is also used as stated above to provide shelter for seedlings of the forest plantations. The young forest trees are afforded a light shade by the *Leucæna glauca*, and when they have attained a fair size, it is cut out and used as fuel. Actual figures are available from the Philippines as to the quantities of fuel yielded by this tree. Experimental plots have yielded average returns of 10 cords (nearly 50 cubic yards) of fuel per acre per year. The fuel has a high calorific value, and it is considered to be a high class fuel wood. It has a straight grain, and splits easily.

In Java it is reported that plantations of this plant are being made for fuel purposes, and it is worthy of consideration whether it would not be useful in Ceylon for providing fuel for tea factories in some districts where a shortage of fuel is now being felt. The wood is also employed in Java for wagon bars, and for such it is favourably reported upon.

No accurate data appear to be available as to the age at which plantations could be first coppiced in the Colony, but judging from growth at the Experiment Station, Peradeniya, it might be expected that the first cutting would be possible at the end of three years under average conditions.

Leucæna glauca is also known as a soil renovator. It is the general experience in all countries that soil under this plant subsequently taken into cultivation is of good fertility, and there are instances of poor land being improved by being allowed to remain for some years under it.

Whilst there are no recorded or known instances of *Leucæna glauca* spreading rapidly on its own accord in any parts of Ceylon, it appears to grow satisfactorily under varied soil and climatic conditions. It would appear that the plant is most suited to semi-tropical conditions and to those localities that do not have too high a rainfall.

In view of the possibility of a fuel shortage for certain tea growing areas in the not far distant future, it is probable that the plant is worthy of experimental trial, and any records of its growth in various districts of the Colony would be welcomed by the Department.

For those who would desire to make experiments with this plant either for fuel, green manure, or for fodder or stock food, seed will be available from the Manager, Experiment Station, Peradeniya, at Rs. 2·00 per lb.

FIBRES.

SISAL IN THE HAWAIIAN ISLANDS.

VAUGHAN MacCAUGHEY, *Professor of Botany, College of Hawaii* and
WILLIAM WEINRICH, *Manager of the Hawaiian Fibre Company.*

Sisal is second only to cotton in being the most extensively used fibre in the United States. Its importance as the basis of binder-twine is steadily increasing. It is a tropical crop, however, and is practically unknown to the average American farmer. The peninsula of Yucatan is the greatest sisal-producing region in the world, and supplies 90 per cent. of the world's sisal.

The only important sisal-growing part of the United States is the Territory of Hawaii. Sisal has been raised successfully in the Hawaiian Islands for over two decades, and is now firmly established as an important agricultural industry. There has been no recent or comprehensive account of the sisal industry in Hawaii, and the present paper undertakes to give an up-to-date statement concerning this valuable crop plant.

Sisal fibre owes its name to the fact that it was first exported through the port of Sisal, Yucatan, just as Manila hemp received its name from its chief shipping point. Sisal is derived from the leaves of two closely related plants,—*Agave rigida* var. *elongata* Baker, the henequen, and var. *Sisalana* Engelman, the true sisal. Both are native to Yucatan. They belong to the Amaryllis family and are similar in appearance to the ornamental agaves. All species of this group are natives of Mexico, where they are called *maguey*. They furnish a variety of economic products, among which fibre, cloth, a food, soap, *pulque*, and *mescal* are prominent. The Agaves flower so infrequently in the temperate zone that they have long been known under the misleading name of "century plants."

The sisal industry was probably started in Yucatan by the Toltecs, who emigrated to Campeachy from Central America about A.D. 1060. The economic value of the fibre was quickly perceived by the early Spanish explorers, whose navy was in need of cordage to replace the depleted stores of Manila hemp (*abaca*). In 1783 a Spanish commission made investigations in Yucatan, reported favourably, and industrial development began. The plantations rapidly became so lucrative that the Spanish owners made every effort to maintain a close monopoly. No plants suitable for propagation were permitted to leave the country. When international courtesy demanded a few plants for research, they were treated, before shipment, so as not to grow.

However, in 1836, before the value of the sisal monopoly had been fully realized by the Spaniards themselves, DR. HENRY PERRINE, United States Consul at Campeachy, introduced into Florida a few plants from the vicinity of Merida, Yucatan. In later years stock from the Florida plants was carried to the Bahamas, Trinidad, and many other parts of the world.

In 1893 the Hawaiian Commissioner of Agriculture and Forestry imported about 20,000 sisal plants from REASONER BROS., Oneca, Florida. The favourable results of the experimental work in Hawaii led to the organization, in

1898, of the Hawaiian Fibre Company. This corporation secured about 300 acres on the coral limestone coastal plain which skirts leeward Oahu, and began planting on a commercial basis. The original investment represented about $37,000. The lands of this company now (1917) comprise about 3,000 acres, with a capitalization of $150,000, and an annual yield of about 500 tons. The company employs about 60 labourers, men and women; at present all are Japanese. The minimum wage is $1·25 per day (U. S. gold); in addition to this, living quarters, land for gardens, water, fuel, insurance and medical attendance are furnished gratis by the company. These overhead expenses for labour represent about 25 cents per day per labourer. These wages correspond with those of the sugar and pine-apple plantations for the same classes of labour, and strikingly indicate that Hawaii, contrary to popular opinion upon the mainland, does not possess "cheap labour."

During the decade 1895-1905 sisal plantings were started under various auspices on all the large islands of the group, but most of these are now neglected or virtually abandoned. There are now (1917) commercial plantations only on the islands of Oahu and Hawaii. On the latter island are two,—that of McWAYNE, at Kailua, 500 acres; and that of the Hawaiian Agricultural Company at Pahala, about 500 acres.

Both varieties of sisal, *elongata* and *Sisalana*, are perennial, with rosettes of 50-75 leaves. These are nearly straight, erect or spreading, 3-6 ft. long, 3-5½ in. wide, and about ¼ in. thick above the base. The apex terminates in a sharp spine about 1 in. long. The henequen (*elongata*) develops a distinct trunk 3-6 ft. high. Its leaves are 2-2½ in. thick at the base, and are always armed with conspicuous marginal spines or hooks. It has a life period of 15-25 years.

Sisal (*Sisalana*) has a very short trunk. The leaves are rarely more than 1 in. thick at the base; are pale green but not glaucous and are 4-6 ft. long by 4-5½ in. wide. They are usually smooth-margined but sometimes bear here and there a few unequal spines. The young Hawaiian sisal plants have foliage with marginal spines, but these spines disappear as the plants grow older. This fact corroborates the theory that *Sisalana* is derived from *elongata* or an equivalent form; the latter probably represents a more primitive condition. The terminal spine of sisal is stout, and purplish-black in colour. Sisal produces a stronger, softer, whiter fibre than henequen, but in somewhat less quantity. Its life period is about 8-10 years, as contrasted with the 15-25 year life of henequen and this shortness of life constitutes one of the large problems of sisal culture. *Sisalana* is raised in the Bahamas, Turks and Caicos Islands, Santo Domingo, Central America, East Africa, India, Java, and the Hawaiian Islands. However, the production of henequen in Yucatan greatly exceeds the combined production of all other localities.

Upon maturity the sisal plant sends up a flowering pole or scape 20-30 ft. high. The pole is 3-6 in. in diameter at the base; the outer layer or rind becomes hard and dry, whereas the interior is soft and pithy. Economically the poles constitute a waste product; they have a low fuel value and but few practical uses. The panicle is about 8 ft. long and 4 ft. wide. There are 30-40 horizontal candelabrum-like branches in the panicle; the largest, near the middle, are 2 or more feet long, the upper and lower ones are shorter. At the ends of the branches are borne dense clusters of erect flowers. These are almost invariably sterile; seed capsules are very rare, except when

produced artificially by means of careful hand pollination. Normally, in the course of a few days the flowers wither and drop, functionless, and are quickly succeeded by the vegetative bulbils, which will be described later. In its flowering habit the sisal may be compared with the Hawaiian bananas, which produce huge quantities of flowers that never seed : reproduction has become wholly vegetative and asexual.

The root system of the sisal plant is relatively simple. The roots extend out near the surface, rarely descending below 12-18 inches. When given sufficient room the roots will generally spread out over an area equal to that covered by the mature leaves.

The so-called "Malina" sisal is *Furcræa gigantea*, allied to the agaves. It is common in old gardens and along roadsides and waste places. It is now thoroughly naturalized, and is known to the Hawaiians as "*Malina*" (their rendering of Manila, in reference to its hemp-like qualities). The plant is a gigantic rosette, resembling sisal in aspect, except that the leaves of Furcræa are larger, broader, and thinner, and much darker green. The fibre, known commercially as *pita*, is long and fine, but inferior to sisal in strength. It is extensively cultivated in Mauritius, and is commercially called "Mauritius hemp."

Sisal fibre is hard or harsh, 3-5 ft. long, and tending to be somewhat coarse and stiff. It is light yellow or nearly white in colour, lighter in shade than henequen, and much paler than Manila. It is heavier than Manila but its working strength is about one-tenth less than that of Manila of the same size and type. Sisal fibre is used most extensively for binder twine. It is also used for lariats and general small cordage of one inch diameter and under, for use on land. Sisal is not generally considered suitable for hoisting ropes or for marine cordage. This is its greatest handicap ; on the other hand, alleged sisal rope is often heavily adulterated.

Hawaiian sisal for many years has demonstrated in the open market its superiority over that produced elsewhere. This has been corroborated repeatedly by fibre experts. It has uniformly commanded better prices than the best grades of hene quengrown in Yucatan.

The yield of fibre is 3-4% of the weight of the green leaves. The average yield of clean dry fibre is 500-1,200 lb. per acre. One thousand leaves produce about 50 lb. of clean fibre. Of the 4 % available fibre in the sisal leaves, a certain percentage is wasted in the machine-milling. This waste can be dried, carded, and worked into a material for stuffing mattresses. This sisal mattress-fibre is excellent for the tropics, being light and cool and distinctly sanitary. The short waste fibres also can be used for making a paper, much like Manila, and used for wrapping, etc.

The watery leaf-pulp, which is very acid, is returned to the fields as a fertilizer. This material possesses possibilities as a by-product that have not yet been developed.

Sisal fibre has a world market and shipments go from Hawaii to many ports. San Francisco, New York, and Japan are the chief markets. Practically the only competition is that of Yucatan, which raises 90% of the world crop. Hawaii contributes about one-tenth of one per cent., and does not begin to supply the demands for her sisal. The United States imports

annually from 15 to 18 million dollars worth of sisal and henequen fibre, most of which goes into binder-twine. The steadily increasing demand for sisal fibre is concomitant with the rapidly extending utilization of mechanical grain binders, using twine, throughout the world. The shipments of sisal from Hawaii to the United States mainland for the past six years, have been as follows :—

Year ending June 30.	*Tons.*	*Value.*
1916	445	$68,764
1915	474	52,608
1914	457	59,915
1913	325	44,221
1912	334	34,499
1911	151	15,096

Sisal is characteristic of regions possessing a continuous warm aud somewhat dry climate. Contrary to popular opinion, it is not highly xerophytic, but it is destroyed by light frosts. It is erroneously reported to successfully endure the latter in the Tamaulipas district; the lowest recorded temperature in the sisal-growing districts of Yucatan is 48° ; the annual precipitation is 29-39 inches. The altitudinal range is relatively narrow. Most sisal land lies at elevations of not more than 100 feet above sea level. It is successfully grown, however, up to altitude of 2,500 ft. The main plantings of the Hawaiian Fibre Company lie at about 700 ft.

Sisal is exacting in its requirements with reference to shade and soil water. It will not grow in swampy soil where its roots are immersed in stagnant water ; it is intolerant of shade. The best sisal lands are brilliantly illuminated, thoroughly drained plains, with rich soil and fairly abundant rainfall. Although sisal can and does grow successfully on thin, dry, rocky soil, the quality and yield of fibre is markedly improved when the plant is raised under optimum conditions of rainfall, soil fertility, and cultivation.

The rainfall on the Oahu sisal lands is about 30 inches per annum. No artificial irrigation is undertaken as there is no available water. Despite the popular impression that sisal has very low water requirements, it is unquestionably true that this crop will respond generously to increased water supply. If water could be obtained at low cost the increased yield of fibre would probably more than pay for the expense of irrigation, and the life of the plant lengthened. There seems to be practically no data concerning the response of sisal to irrigation.

Sisal planted on the same land indefinitely without rotation contrary to popular tradition does *not* deteriorate and become unprofitable. The plant feeds most heavily on lime, magnesia, potash and phosphoric acid. The important ash constituent of the green leaves and fibre are—

	Green leaves.	Fibre.
Lime	33·4 %	36·2 %
Potash	18·8	15·8
Magnesia	15·4	1·4
Phosphoric acid	3·3	2·6

The optimum conditions for sisal seem to be,—an arable lava, limestone or coral soil, high temperature subject to only moderate changes, and a moderate degree of moisture.

Hawaiian sisal is notably free from insect pests and fungous diseases. The plants are uniformly clean and sound, and their life is terminated only by their own physiological boundaries. Occasionally, through carelessness or misfortune, a fire gets started in the dry weeds and brush between the rows. This ruins all of the sisal plants with which it comes in contact. Fires of this kind are counted among the most serious enemies of sisal.

Sisal leaves do not drop off or separate themselves from the parent plant. Normally, upon maturity, they droop groundward and become dry, leathery, and shrivelled. When the whole plant finally dies it remains *in situ* for a number of years, a mass of debris, surrounded by offshoots in various stages of development.

Two wholly distinct sets of structures for vegetative reproduction are produced by the sisal plant,—offshoots and bulbils. The offshoots or suckers (rhizomes) are formed after the first or second year in the field and their production continues until the death of the plant. Bulbils ("pole" or "mast" plants) are formed only upon the pole or scape, and thus come only once in the life history of the plant, just prior to its death. The offshoots develop from the roots and come up through the soil in the immediate vicinity of the parent plants, although sometimes at a distance of 6-12 feet. There are usually 6-18 offshoots around a mature sisal plant. The aerial portion is 8-24 inches high, and is a miniature rosette, resembling the parent plant. It obtains food not only from its own roots, but also from the runner from the parent plant. These suckers correspond in structure and function to the suckers that occur on such other tropical plants as the targo, date palm, pine-apple plant, banana, etc.

The bulbils are formed on the branches of the pole, after the flowers have fallen. One to four-thousand bulbils are borne upon a single pole. The bulbils are 1-6 inches long, and comprise several fleshy leaves upon a short stem. They fall to the ground and root, and may be gathered for propagation. Bulbils are not as good as offshoots however, as they require 1-2 years in a nursery before they are suitable for planting out in the fields. When about 1 ft. high the nursery plants are dug, all the roots and about half of the leaves are cut off, and the plants are allowed to dry for 1-3 months. Plants thus treated are better for transplanting and respond more quickly in the field.

After a year's growth the offshoots are suitable for propagation. It is customary to dry them for several months before planting, just as in the case of the bulbils; this drying appears to aid the plant in making a good start after being set out. In general, offshoots are universally used for propagation, except for starting plantations at long distances, where bulbils are sometimes used, as they are smaller and more easily transported.

The young plants are usually set out at the beginning of the rainy season, in order that they may receive its full benefits. In the Hawaiian Islands the rains begin in November and continue until March or April. The difference between summer and winter is slight, however, both as to rainfall and as to temperature. From 500 to 1000 plants are set to the acre, the number varying with topography and soil conditions. The planting distances are 6 × 6, 9 × 10, 9 × 12 feet, etc. The Hawaiian Fibre Company uses 9 × 6 feet as its standard for planting. The land is kept free from weeds and brush by occasional cultivations, averaging once every 3-6 months.

The Hawaiian sisal leaves are not cut until the plants are four years old. After the first cutting the plants live about five years; then the flowering

poles are thrown up and the life of the plant soon terminates. 10-20 leaves are taken off each plant at each harvesting. The leaves are cut when 3-5 ft. long and when the lower ones are nearly horizontal. Only the lower leaves are taken. In the Bahamas the first crop is cut the third or fourth year after the plants are set and annual crops are secured thereafter for 6-12 years. In Yucatan the first crop is not cut until the sixth or seventh year, and after that a crop is gathered every 8 months for 15-25 years. The leaves are tied into bundles of 50 each, for transporting to the mill. At the time of poling the average sisal plant has produced about 135 leaves, of which 100 are mature or nearly so, and 35 leaves which will mature within one year, providing the pole is cut off just at the base of the uppermost leaves

Sisal fibre is removed from the leaf in two ways, by hand and by machinery. Practically all of the commercial fibre is removed by machinery. As is true of other fibres, however, the hand-cleaned sisal fibre is distinctly superior for certain purposes to the machine-cleaned product. In certain sections of Yucatan and Mexico the natives clean the fibre by hand; one man can clean 6-9 lb. per day. This fibre is used exclusively for the manufacture of fine hammocks, which sell for their weight in silver.

The various types of scutching or decorticating machines closely resemble one another in principle. The fresh green leaves are fed sidewise into the machine at the rate of 30,000-40,000 leaves per day. About 20 seconds are required in which to clean a single leaf. The green juicy pulp or parenchymous tissue, which comprises the bulk of the interior of the leaf, is crushed, beaten, and scraped away by blunt knives fastened to 2 rapidly revolving drums. As an excellent instance of the unnecessary complexity of some of this sisal machinery may be cited the case of the Hawaiian Fibre Company. *Two tons* of gear-wheels were removed from a single machine, greatly increasing its efficiency and at the same time reducing the cost of operation.

The sisal juice contains very strong acids that are destructive to all sorts of common materials,—iron, cement, leather, wood, etc.,—with the exception of bronze. All working parts of the sisal machine, that come in direct contact with the sisal juice, are therefore constructed of bronze. In some machines streams of water play upon the fibre as the latter passes through the scutching wheels.

The fibre is taken directly from the machine to the drying yard where it is spread out in the hot sunshine to dry and bleach. It is laid flat on the smooth floor of crushed coral, and turned once. This process requires about 6 hours. The dry fibre is well brushed, so that all the fibres are parallel with one another. The short, kinked, and waste fibre is sorted out. Finally the fibre is baled into bales weighing about 700 lb. The baling box is 4 ft. 6 in. × 2 ft. 6 in. × 2 ft. 6 in. and is operated by hydraulic pressure. The bales require no covering, and are tied with ropes made of the twisted fibre. They are taken to the shipping point, Honolulu, by railroad train.

During the past two years experiments have been carried on in Hawaii to produce a hybrid sisal derived from the two parents *elongata* and *sisalana*. It is hoped that this hybrid will produce the superior qualities of fibre from the *sisalana* and partake of the much desired quality of long life of the henequen. Experimentation of this kind is not known by the authors to have been attempted in any other part of the world.

There are also under way, in Hawaii, chemical investigations of the waste product. These studies indicate that valuable properties are undoubtedly latent in the sisal wastes.

It is to be greatly regretted that many of the uses of sisal and its numerous varieties have passed out with the passing of a great race, the Toltecs, who thoroughly understood the culture and uses of this plant.

SOILS AND MANURES.

MAKING AND STORING FARM-YARD MANURE.

Wherever there is a farmer in any part of the world, whatever the crop he cultivates, he has to face the question of preserving or increasing the productiveness of his land. The fact, that the fertility of soil decreases after continually taking crops off it, was recognized long before the reason of this decrease was known, and the practical method of preserving fertility by the application of manure was acted on probably long before the beginning of history. It is certain that the earliest writers on practical agriculture whose books have come down to our age knew the value of farm-yard manure, and gave directions about its use as the great fertilizer of the soil.

VARRO, who lived from 116 to 27 B.C., has been called the father of agriculture, because of his treatise in three books, *De Re Rustica*, which treats systematically of agricultural practice, and is the earliest work of the kind which has survived to the present day. He has much to say about the art of managing the manure on a farm. He insists on two points: first, that the manure should be rotted before being applied to the land, and that there must therefore be two heaps—one fresh and one rotted; secondly, that the heaps should be kept moist by allowing water to run on to them, and by protecting their sides with twigs and leaves. COLUMELLA, another Latin writer, whose treatise in twelve books, under the same title as that of VARRO'S, has also survived to our day, gives many directions as to the storing and utilization of farm-yard manure. He gives instructions as to the manner of constructing the place or pit where the manure is to be kept, and also emphasizes the necessity of applying only rotted manure to corn, although fresh manure might be well applied to grass. These precepts of VARRO and COLUMELLA became the recognised method of dealing with farm-yard manure through Europe until well into the 18th century. This practice may be summed up as follows :—

1. The manure must not be allowed to become dry.
2. It must be rotted before being applied to corn.

No attention was paid to bad effects of rain on a manure heap, as neither of those authors had anything to say about it.

A paper in THE JOURNAL OF THE ROYAL AGRICULTURAL SOCIETY OF ENGLAND, Vol. 77, 1915, by E. J. RUSSELL, D. Sc., and E. H. RICHARDS, from which the present article largely draws, deals with this subject from the point of view of results of experiments during the previous three years at Rothamsted and Cambridge.

The subject is of quite as much importance to modern agriculturists as it was to the ancients, and to those of tropical countries as to those in the temperate zone. For not only is farmyard manure the most widely used fertilizer, but the amount used much exceeds both in weight and value that of all other fertilizers put together. In the United Kingdom alone the weight of farmyard manure made use of in the year before the war was estimated at 37,000,000 tons, valued at £11,000,000, while the weight of all other fertilizers used was 1,105,000 tons, valued at £4,540,000. In most other agricultural countries the proportion of farm-yard to artificial manures is probably still greater. Seeing then that farm-yard manure is of such prime importance in agricultural economy, it is evident that waste of its most valuable constituents should be minimized as much as possible, unfortunately this is under ordinary conditions of making and storing, very considerable. Investigation into the causes of this wastage is by no means easy, for farm-yard manure is variable in composition, and difficult to sample and analyse satisfactorily, so as to obtain reliable conclusions. The problem is being definitely attacked, however, and some definite results have been reached.

It must be remembered that, apart from litter, straw, etc., added to it, what is known as farm-yard manure is made up of two kinds of excretions ; the solid fæces, which is the undigested material that the animals' alimentary canal has been unable to deal with ; and the urine, containing the digested material, after it has been dissolved, assimilated, and passed out of the animal's body.

Now modern analyses have shown that the urine contains a far greater percentage of the most valuable fertilizers, nitrogen and potash, than the solid fæces ; and further that the nitrogen and potash of the urine are of more fertilizing value than the same constituents of the fæces, because the former are already dissolved, and capable of immediate assimilation by plants.

It is impossible, however, in making farm-yard manure to collect all the urine ; consequent on this are the differences noted in analyses of farmyard manures. It has been demonstrated, however, that the manure coming from animals well fed on oil cake is richer in nitrogen and phosphates than that from animals deprived of such nitrogenous food.

Experiments at Rothamsted were planned for the purpose of finding out how to preserve the best elements in farm-yard manure. In the first place it was demonstrated that a manure heap should be compacted as a measure of precaution, because the loss of nitrogen, and phosphates from a compacted heap, as compared with that from a loose heap, shows that the expense of compacting is quite justified. The common practice in the West Indies of keeping the manure in the cattle shed until wanted for use, is to be commended in this connection. The continual trampling of the cattle does much towards effective compacting.

The next series of experiments was to discover whether sheltering of a manure heap from weather and rain was of any benefit. Here the result showed that between unexposed and exposed manure there was a very great

difference emphasizing the necessity of shelter for manure heaps. The conclusion drawn from this series of experiments is that the provision of shelter for the manure heap is very important, and that serious losses arise when manure is exposed to the weather. Compacting the heap only slightly diminishes the losses; the only way of dealing with them is to provide a shelter or some sort to the heap.

An objection to sheltering a manure heap is that it tends to make the manure too dry, which is correct to a certain extent, inasmuch as dryness tends to encourage nitrate formation which is not especially desirable and to discourage the decomposition of the litter, which is eminently desirable. But to try and add water to a sheltered heap only makes matters worse; the loss of nitrogen only becomes more marked. Direct field experiments show that the best course to pursue is to shelter the manure heap, but to check the tendency to become dry by keeping it as compact as possible.

Further experiments showed that manure retains its fertilizing constituents best when it is :—

a. Kept compact.

b. Sufficiently moist, but not too wet.

c. Under shelter, and not stirred up.

Yet all these precautions only retard inevitable loss. So the question is, can not the loss in the beneficial constituents of manure be altogether avoided?

Experiments designed to find out what processes go on in a manure heap, and why losses arise, have to be carried out primarily in the laboratory. But what is discovered in the laboratory holds good in the field. From careful laboratory experiments the following conclusions were arrived at :—

1. The loss of nitrogen from a manure heap is partly due to three causes : (a) the washing away of soluble substances ; (b) the volatilization of ammonia ; (c) the liberation of some other gas, presumably gaseous nitrogen.

2. These losses begin as soon as the air is allowed to enter the heap, and they become more intense as the temperature rises.

3. The losses do not take place when air is completely excluded from the manure.

4. When air is completely excluded, and the temperature is caused to rise, not only is there no loss, but a distinct improvement in quality takes place.

Both the laboratory analyses and field experiments thus show that exposure to atmospheric influences causes a loss in quantity and quality of the manure. No manure heap, however, has yet been made which will absolutely meet the conditions of conclusions 3 and 4. Still it is clear that it is to the advantage of the farmer to endeavour to store his manure in such a way as to approximate to those conditions as nearly as possible.

The common method of making up manure in the open with no shelter over it must be condemned, as most surely causing very considerable loss in quality. There is no question but that some shelter from rain is most necessary, and that the heap should be compacted as closely as possible. In all

cases special care must be taken of any liquid draining away from the manure heap. Some kind of a tank ought to be made to hold it. This liquid should not be poured back on the manure except just before spreading, but it ought to be applied to the land separately. The use of this and of urine as liquid manure produces excellent results.

Even with these precautions it is still certain that large wastage takes place at present in the making and storing of farm-yard manure. The laboratory experiments show that not only can manure be stored without loss, if air and water are completely excluded, but that positive gain in quality is produced, if, in addition, the temperature is raised. The conclusion, therefore, is that the only method of excluding the air in practice would be to store the manure in air-tight tanks or pits.

In the West Indies the question of increased temperature is arranged for by nature. The details of construction of such tanks or pits would have to be carefully worked out, so as to discover how far the gain in fertilizing power of the manure would counterbalance the expense of such a tank or pit. It would seem, however, that any attempts to avoid loss in making and storing manure will have to be on these lines, and the possible gain to the former makes it a subject worth most careful attention.—THE AGRIC. NEWS, Barbados, Oct. 30, 1917.

POTASH FROM A NEW SOURCE.

A new source of supply for potash has been found. Since the war has, in a large measure, shut off the supply of potash and so much depends upon the cultivation of the soil, every new supply counts.

It has been discovered that large quantities of the dust that accumulates in certain portions of the apparatus used in making pig iron from iron ore—that is, in the blast furnaces—contains appreciable quantities of potash. The amount found depends upon the kind of ore used in the blast furnace charge. As the charge of ore, limestone, coke, etc., passes down the blunt furnace, quantities of dust, fine ore and products of the smelting operation are carried out at the top of the gases. From these gases the dust is collected or deposits itself in various places in the system of flues and stoves.

The recovery of potash from blast furnace operation has been particularly investigated by the superintendent of blast furnaces of one of the largest steel companies in the country. He states that the ores used by his company are of such a nature that potash is now more abundantly produced as a by-product than at some other plants using iron ores. From April 1, 1915, to July 1, 1916, he states that 1,074 net tons of dust in carloads containing an average potash (K_2O) content of 9·9 per cent. were collected. Instead of being dumped into a dirt car this dust was simply emptied into a central bin. Knowing just what dust to recover reclamation was commenced after the war started because of the advance in the price of potash, and a satisfactory contract for its sale was negotiated. The company has been disposing of the dust at a good profit ever since.—MYSORE ECONOMIC JOURNAL, October, 1917.

TOBACCO.

RESEARCHES ON TOBACCO.

There is much that is of interest to tobacco planters in Ridgeway's studies on "Grain of the Tobacco Leaf" (JOURN. AGRIC. RESEARCH vii. 6.p. 269). Such suggestions as 'Rapid curing ("haying-down") causes an imperfect aggregation of grain and poor burning qualities' and 'a low degree of grain aggregation is apparently connected with a high-chlorine content' or 'storage of leaf improves the burning qualities because of its connection with slow aggregation of grain bodies rather than due to the loss through aging of some substances injurious to the burning quality' are startling in their novelty. If further researches confirm the validity of these beliefs our views on curing etc. might have to undergo a revision.

Grain bodies develop only after harvesting. Their development might be connected with highly refractive droplets which on the drying of the leaf seem to migrate towards those which had produced crystal nuclei and thus increase by accretion to form a solid grain body. The factors which determine the number and distribution of these nuclei are not known but it is thought that the rate of desiccation and the degree of maturity of the curing leaves are of importance. This appears to be supported by the fact that all aircured [cigar] types possess grain in some degree whilst in flue-cured types it is not evident. In flue-cured leaf the substance which would have aggregated into more or less definite grain bodies are deposited in the form of a haze of minute crystals throughout the tissues of the leaf,—curing and drying being too rapid to permit of such aggregations. When undergoing fermentation it is believed that the highwater content of the fermenting tissue results in a re-solution of the grain substance particularly of the smaller bodies and this aggregates round other grains. It is to this that the improvement of the burning qualities of the leaf with storage is attributed as above mentioned.

The grain of cigar tobacco, based upon microscopic features enable the recognition of five forms the significance of which is still a matter to be investigated. They are shown to consist chiefly of calcium with a little magnesium and potassium in combination with citric and malic acid rather than of oxalic acid. There is thus no foundation whatever for the view held by many that they are composed of potassium nitrate.

The assertion by experts that a "close grained" leaf will burn poorly whilst one possessing an "open-grain" will have a greater fire-holding capacity is correct. This is stated to be due to the fact that the grain substance is injurious to the burn retarding the advance of fire. In an "open-grain" leaf the substances are aggregated and sufficiently far apart to permit fire to advance rapidly through cells emptied of grain material. Thus it is that the degree of aggregation influences the burning quality.

The influence of the degree of aggregation of the grain substance upon such factors as colour, texture, and elasticity of the leaf is still to be investigated. Whilst the character of the grain is only a minor consideration in

fixing the value of a given sample, its correlation with other factors will undoubtedly lead to making it more important than has hitherto been supposed.

ALLARD (Am. Journ. of Bot. iii. 9.p. 493) confirms by physiological experiments what EAST, HAYES and REINHART had previously shown from statistical studies that environmental conditions have little if no effect upon the *number* of leaves produced by a tobacco plant. Drought may stunt the size of leaf, plant or even inflorescence but the variation in the number of leaves is not due to drought or to conditions unfavourable to growth. It is tentatively suggested that "nutritional differences during some initial period of embryonic development determine leaf number."

H. L. VAN B.

LIFE HISTORY AND HABITS OF THE TOBACCO BEETLE *LASIODERMA SERRICORNE* FABRICIUS.

G. A. RUNNER.

THE EGGS.

Period of Incubation.—The egg stage at ordinary temperatures in summer lasts from 6 to 10 days. In warm weather during summer it averages about 8 days. Eggs kept at a constant temperature of 80°F. nearly all hatch the sixth or seventh day after they are laid. Cool weather may retard hatching for a considerable time.

THE LARVÆ.

Newly hatched larvæ are somewhat more active than later, and owing to their extremely small size readily enter boxes or containers holding tobacco. When exposed to light, the larvæ disappear within the food substance or under cover as quickly as possible. They are able to crawl for short distances and often migrate from infested to uninfested material. This habit sometimes accounts for the quick appearance of injury in freshly made cigars. Partly grown larvæ shaken from leaf tobacco have been found on cigar makers' tables. These larvæ easily enter the open ends of the cigars, and in a very short time their work may be noticed in the bundle or box of finished cigars. Several cigars in a box or package may be injured by a single larvæ. Preference is shown for the thinner or chaffy leaves of cured tobacco, and for certain types of high grade that are mild and sweet flavoured. Strong, heavy types of leaf tobacco ordinarily are not injured to such an extent as are the milder or thinner types, unless stored for a long time. Leaf tobacco which is fire cured or smoke cured, such as that grown in the dark-tobacco sections of Virginia and in the "black patch" of Kentucky and Tennessee, seldom is badly injured. This is due in part, perhaps, to the flavour or quality given the leaf by the smoke, as well as to the natural qualities of tobacco of this type. The smoke seems to act for a time as a repellent, since the same type of leaf, flue cured, is attacked readily, although not to so great an extent as lighter bodied types. These types, as well as all others, however, are more likely to be injured after the leaf has

become aged. The changes brought about by long storage of any tobacco seem in some way to make it more acceptable as food for the larvæ.

Length of Larva Stage.—At ordinary room temperatures in summer the larva or feeding stage extends over a period of from 30 to 70 days, depending mainly on the temperature and on the character, abundance, and condition of food. In cold weather the larvæ become dormant and may remain in this condition for some time. It is mainly in this stage, in cool climates, that the insect passes the winter. When the larvæ have finished feeding and are incased within the pupal cells they are able, either as larvæ or as pupæ, to stand a considerable degree of cold. Larvæ within the cells are also more able to resist treatment with fumigants. Activity in the larva stage ceases at temperatures ranging from 60° to 67° F. The most favourable conditions for rapid development of larvæ are a suitable food substance in a compact or concentrated form, high and uniform temperature, high humidity, and protection from strong light and from rapid evaporation.

The Pupal Cells.—After the larvæ have become fully grown and ready to transform to the pupa stage they construct cells or cocoons, usually within the food substance. In leaf tobacco these cells usually are found along the midrib or in folds of the leaf. In boxes of cigars some of the cells may be found between the cigars and the sides of the box, but the greater number are found within the cigar. In leaf tobacco the cells frequently are incomplete, the larvæ using folds of the leaf for part of the cells. Within dense substances the surrounding material forms the necessary protection, the walls of the cell being fragile and thinly lined. The cells are more or less egg-shaped and about one-fifth of an inch long. Often they are without definite shape.

The Prepupa Stage.—Before transformation to pupæ there is ordinarily a period of from 4 to 12 days during which the larvæ within the cells undergo structural changes, but if exposed to low temperatures they may remain in the cells for a considerable time before these changes take place. Before changing to pupæ the larvæ lie in a curved position within their cells, and their movements cause the cells to become considerably larger than the larvæ. Their bodies then contract and become more deeply wrinkled.

THE PUPÆ.

The pupa stage of the tobacco beetle at room temperatures during the warmer months of the year lasts from 5 to 10 days. The average of 38 records obtained at Tampa, Fla., during July, 1913, was found to be 7·8 days.

THE ADULTS.

When the change to the beetle or adult stage has taken place the beetles remain inactive in the cells for from 3 to 7 days. After emerging they remain at rest for a day or more, their colour gradually deepening to reddish brown. At first the beetles are comparatively soft, and they do not attain their final degree of hardness until they are ready to move away from the pupal cell. They crawl or fly about actively and are capable of flying for a considerable distance. They avoid intense light and move about most actively in subdued light or in darkness. When in the dark they are attracted toward subdued daylight or to artificial light. In tobacco warehouses they may often be found in large numbers at the windows in late

afternoon, the flight toward the windows being heaviest at sunset. During the day the beetles will be found most numerous in secluded places, such as crevices in the walls or in the leaf tobacco. They have a habit of feigning death when disturbed. The adults generally begin to mate the second or third day after becoming fully mature. In tobacco warehouses the beetles seldom are found active at temperatures below 65° F. Activity increases as the temperature becomes higher, but ceases between 117° and 120° F.

Length of the Adult Stage.—In warm rooms, or in summer, the beetles die much sooner than when emergence occurs during cooler weather. Although they may gnaw through tobacco or other food substances to escape from the locality where transformation took place, little evidence of feeding has been observed. Adults have been found to lay eggs and live the normal length of time whether food was present or not. Under usual conditions they live from three to six weeks.

Oviposition.—Egg laying usually begins in from two to six days after emergence. In warm places where tobacco is not subjected to temperatures much below 70° F., eggs may be found at any time. In the Middle and Northern States, where tobacco is kept in unheated buildings and the temperature is about the same as out of doors, the eggs are laid only during the warmer months of the year. In experiments at Richmond, Va., the last eggs were obtained from beetles kept in an unheated building on October 28th, 1914, and the first eggs were obtained the following spring on May 2nd. There seems to be a rather common belief that the eggs are laid on the leaf of tobacco in the fields or during the process of curing, and that these eggs do not develop until the tobacco is handled or made up into cigars or other products. This is not the case, as the eggs at ordinary temperatures hatch a few days after they are laid, and the beetle does not infest tobacco until after it is cured. The eggs adhere very lightly to leaf tobacco and are dislodged easily by handling. The beetles deposit their eggs in crevices or folds of the leaf, or in secluded places away from the light, and where the closely packed food substances protects the eggs from evaporation. The egg-laying period normally lasts from 2 to 17 days, and the number laid by each female is approximately 25 to 30.

SUMMARY OF LIFE HISTORY.

The insect lives in its food substance during all stages of its existence. In tobacco or other food substance kept constantly warm breeding is continuous, and there may be as many as five or six generations a year. Under such conditions in tobacco warehouses in the latitude of Virginia and Tennessee there are three or four generations a year. The time required to complete the life cycle of the insect depends mainly upon temperature and may be as short as 45 days, normally varying in summer from 45 to 70 days. Eggs are laid in the food substance. They hatch in from 6 to 10 days. The larva period is from 30 to 50 days and the pupa period from 6 to 10 days. Under usual conditions adults live from three to six weeks. In temperate climates the insect passes the winter mainly in the larva stage. It thrives best where the temperature and humidity are high and in tobacco or other food substances protected from rapid evaporation.—EXTRACT FROM FARMERS' BULLETIN 846, UNITED STATES DEPARTMENT OF AGRICULTURE.

POULTRY.

EXPERIMENTS WITH LAYING HENS.

W. J. BUSS.

SUMMARY.

RANGE *Vs.* CONFINEMENT.

Experiment Ia.—This experiment was begun May 4, 1912, and lasted 882 days. The fowls used were S. C. White Leghorns hatched in the spring of 1910.

The mortality was 23·23 per cent. for the confined lot and 15·53 per cent. for the lot on range.

There was practically no difference between the two lots in the amount of grain and mash consumed per hen.

The average egg production of the hens on range was 15·4 per cent. higher than that of the hens that were confined.

The cost of feed per dozen eggs produced was 14·8 per cent. higher for the confined lot than for the lot on range. No charge for the range is included in these calculations.

The difference between cost of feed and value of eggs was 27·4 per cent. greater for the range lot than for the confined lot.

The value of range in this experiment was 62 cents per hen.

Both lots of hens were kept in confinement from the time they began to produce eggs in December, 1910, until the beginning of this experiment This doubtless accounts for the relatively small difference in the egg production by the two lots.

Experiment Ib.—This experiment was begun November 30, 1913, with S. C. White Leghorn pullets and was continued for 728 days.

The mortality was 17·5 per cent. for the confined lot and 12·3 per cent. for the lot on range.

The average grain and mash consumption per hen was 1·8 per cent. higher for the range lot than for the confined lot.

The average egg production per hen was 29·8 per cent. higher for the range lot than for the lot in confinement. The egg production of the range lot was unusually high. The average production per hen for the first year was 181·2 eggs, and for the second year 133·3 eggs.

The cost of feed per dozen eggs produced was 26·1 per cent. higher for the confined lot than for the range lot.

The difference between cost of feed and value of eggs was 48·3 per cent. greater for the lot on range than for the confined lot.

The value of range was 86 cents per hen during the first year and 55 cents per hen during the second year.

Experiment Ic.—S. C. White Leghorn pullets were used in this experiment, which was begun November 29, 1914, and lasted 364 days. The pullets gained almost half a pound in weight during the experiment, indicating that they were not as well matured as is desirable at the time of the year when this experiment was begun.

The mortality was practically the same for both lots.

The pullets on range consumed 4·6 per cent. more grain and mash than did those that were confined.

The average egg production was 43·9 per cent. higher for the range lot than for the lot in confinement.

The cost of feed per dozen eggs produced was 36·3 per cent. higher for the confined lot than for the lot on range.

The difference between cost of feed and value of eggs was 70·5 per cent. higher for the lot on range than for the confined lot.

The value of range per pullet in this experiment was 68 cents.

VARIETY *Vs.* SIMPLE RATIONS.

Experiment IIa.—This experiment was begun with S. C. White Leghorn pullets, November 24, 1912, and closed October 6, 1915, lasting 1,047 days.

The mortality was slightly higher for Lot 2, receiving a ration of corn, bran and meat scrap, and Lot 3, receiving a ration of corn, wheat, oats, bran and meat scrap, than for Lot 1, receiving a ration of corn and meat scrap. This difference in mortality may not have been due to the rations fed. The mortality was lower for Lot 3 during the first two years, but much higher during the last period, than for Lots 1 and 2.

The average feed consumption per hen was 9·3 per cent. more for Lot 3, and 3·2 per cent. less for Lot 2 than for Lot 1.

The egg production for Lot 1 was 5·2 per cent. lower than for Lot 3 and 20 per cent higher than for Lot 2.

The cost of feed per dozen eggs was 16·1 per cent. higher for Lots 2 and 3 than for Lot 1.

The difference between cost of feed per hen and value of eggs per hen was $4·18, $3·09, and $4·11 for Lots 1, 2 and 3, respectively.

Experiment IIb.—In this experiment, which was begun December 4, 1913, and covered 672 days, S. C. White Leghorns hatched in the spring of 1913 were used.

The mortality was 20, 32 and 8 per cent for Lots 1, 2 and 3, receiving rations of corn and meat scrap; corn, bran and meat scrap; and corn, wheat, oats, bran, middlings, oilmeal and meat scrap, respectively.

The average feed consumption per hen was 17·4 per cent. more for Lot 3 than for Lots 1 and 2.

The average egg production per hen was 2·1 per cent. higher for Lot 2, and 8·4 per cent. higher for Lot 3 than for Lot 1.

The cost of feed per dozen eggs produced was 27 per cent. higher for Lot 3 than for Lots 1 and 2.

The difference between cost of feed and value of eggs was $2·09, $2·15 and $1·98 per hen, for Lots 1, 2 and 3 respectively.

VARIOUS AMOUNTS OF PROTEIN IN RATIONS : FOR BARRED PLYMOUTH ROCKS.

Pullets hatched in the spring of 1914 were used in this experiment, which was begun December 13, 1914, and lasted 364 days.

The mortality was 28·8, 24·6 and 33·9 per cent. for Lots 1, 2 and 3, receiving rations carrying approximately 10, 15 and 20 per cent. of crude protein, respectively.

The food consumption per pullet for Lot 2 was 13·6 per cent. higher than for Lot 1 and 5·3 per cent. higher than for Lot 3.

Lot 2 produced 50·9 per cent. more eggs per pullet than Lot 1 and 27·8 per cent. more than Lot. 3.

The cost of feed per dozen eggs produced was 15·5 per cent. higher for Lot 1 and 36·9 per cent. for Lot 3 than for Lot 2.

The difference between the cost of feed and the value of eggs was $1·09, $1·81, and $1·05 per pullet for Lots 1, 2 and 3, respectively.

Lot 1 consumed 32·1 per cent. more, and Lot 3, 22 per cent. more dry matter per dozen eggs produced than did Lot 2.

FOR S. C. WHITE LEGHORNS.

The mortality was 8·3, 13·3 and 6·7 per cent. for Lots 1, 2 and 3 respectively.

The feed consumption was practically the same for Lots 2 and 3, Lot 1 consumed 10·9 per cent. less feed per pullet than did Lots 2 and 3.

The egg production per pullet was 53 per cent. higher for Lot 2 than for Lot 1 and 6·6 per cent. higher than for Lot 3.

The cost of feed per dozen eggs produced was 18·7 per cent. higher for Lot 1 and 22·6 per cent. higher for Lot 3 than for Lot 2.

The difference between cost of feed and value of eggs was $1·04, $1·78 and $1·47 for Lots 1, 2 and 3 respectively.

Lot 1 consumed 36·3 per cent. more dry matter per dozen eggs produced, and Lot 3, 8·6 per cent. more than did Lot 1.

The Leghorns required less feed per unit of eggs produced than did the Rocks. The cost of feed per dozen eggs produced was 27·4 per cent. higher for the Rocks than for the Leghorns.

The dry matter required per dozen eggs produced was also approximately 27 per cent. for the Rocks than for the Leghorns.

Experiments similar to those discussed in this bulletin are being continued, and results secured will be published later.—BULL. No. 291, OHIO AGRICULTURAL EXPERIMENT STATION.

RUNNER DUCKS AS FARM LAYERS.

The following note has been communicated to the Board by MR. A. JOHNSON, of Troed-y-Rhiw, North Wales :—

It has often been contended—and, indeed, proved by actual test—that a good strain of laying ducks is more profitable than hens to the average farmer when egg-production is the main object. There are many reasons why this should be so. In the first place, ducks can better withstand extreme cold than ordinary fowls, and this means, that as layers, they are not so easily checked during winter. They are also much less prone to disease, require less attention, are more easily satisfied in the matter of diet and housing, and remain in a condition of prolificacy to a far greater age than does the average hen.

GENERAL CHARACTERISTICS.

The Indian Runner duck is the greatest layer of all waterfowl. Flocks of this breed from a good strain will often average a higher egg-production than hens of selected quality, and most of the eggs will be produced in the winter months. Being great foragers for natural food, Runners are more at home on a farm than anywhere else and given the opportunity, they will roam far and wide the whole day long, and for the greater part of the year practically keep themselves. Feeding is thus reduced to a minimum, and pasture and arable land derive great benefit from such inveterate destroyers of noxious insect pests.

Another important point must not pass unnoticed in regard to this useful little duck. Many farmers say that they will not keep waterfowl because they foul the cattle's drinking water. This is very true in many instances and with most breeds, but the Runner is curiously unlike the remainder of its genus, since it prefers to roam the fields rather than to dabble about in pond and stream. A few years ago a farm was rented by the writer upon which the water supply had to be rigorously conserved. Yet the flock of Indian Runners, which occupied colony houses about the fields, seldom gave any trouble in this respect. These ducks do not possess the same instinct for water and boggy land as others. They can, indeed, be kept in perfect health with nothing more than an ordinary vessel for drinking purposes, and swimming water is not essential to the successful fertilisation of the eggs.

HOUSING.

One of the first essentials to the success of keeping Runner ducks for egg-production on farms is good housing. It is a bad practice to allow the stock to lead a makeshift life if an abundant supply of eggs is required. The birds should be given a dry, well-littered floor, and they should be closed in at night. At least one side of the house should consist of open wire netting, and it is necessary to erect a temporary fence of the same material round the sleeping place. In this improvised pen the flock must remain until about 10 a.m., and there the birds may be given water and their first feed of the day. If this precaution is not taken, many eggs will be laid away and lost. All breeds of duck lay, as a general rule, before the hour stated.

EGG LAYING.

The eggs of the Indian Runner are rather smaller than those of the other breeds, and generally white or cream in colour. A good duck will lay all the year round, with brief intervals, commencing in her first autumn at the age of six months, and continuing in profit until she attains her fourth or fifth year. In individual cases the ducks will often lay longer than that. Indeed, one should not consider a Runner to be at her best until she is at least two-and-a-half years old, though, naturally, individuals vary very considerably. For general purposes the eggs of this wonderfully prolific breed usually fetch rather a higher price than hens' eggs, for they are not only larger but, being entirely free from that strong or "ducky" flavour common to the average duck's egg, they are used for precisely the same purposes as the former.

VARIETY.

There are several varieties of Indian Runner ducks, the fawn and white being perhaps the most reliable. The whites, however, have often proved themselves remarkable layers, and they possess the advantage on the farm that they can more easily be seen. This latter is worth considering in some circumstances, but Runners, though they are such keen foragers, and long-distance wanderers, rarely fail to return to their house at dusk. Some of the writer's flocks would roam half-a-mile away, but they were always at home before night-fall.—JOURN. OF THE BD. OF AGRIC., Oct. 1917.

AGRICULTURAL EDUCATION.

SCHOOL OF TROPICAL AGRICULTURE, PERADENIYA.

REPORT OF HEADMEN'S COURSE, 1917.

1. In terms of Sessional Paper XXXVII, 1909, paras. *q* & *t*, Government Agents were circularised with regard to a course in Agriculture for Headmen. Arrangements were based on the replies received and on considerations of accommodation in Peradeniya. The course commenced on May 15th and ended on December 18th, 1917, covering 26 weeks of work. There was one vacation from September 29th to November 6th.

2. 16 Headmen reported for admission. Of them 13 were Sinhalese and 3 Tamil. They represented the seven following provinces: Western (4), Central (3), North-Western (3), Uva (2), Eastern (2), Northern (1) and Southern (1); and the nine following districts: Kandy (3), Colombo (2), Badulla (2), Kurunegala (2), Kalutara (2), Trincomalie (2), Galle (1), Jaffna (1), and Chilaw (1). The North-Central and Sabaragamuwa Provinces were unrepresented. These classified according to office were as follows :— 2 Koralas, 1 Native Writer, 8 Police Headmen, 4 Arachchies, and 1 Vel Vidane.

3. A house was rented and furnished for the accommodation of the 16 headmen. While in attendance, they received free furnished lodging, free tuition and an allowance of Rs. 10/- per mensem towards the cost of their board. One of the headmen was selected to control the discipline of the hostel as Prefect; and the hostel was inspected at regular intervals by the lecturers in charge, the Registrar and the Principal. The hostel was kept consistently clean and orderly and the conduct of those in residence was excellent. Their health during the course was good; there was no case of epidemic disease. There were a few cases of malaria and influenza.

4. All work was conducted in the vernacular, in Sinhalese by MR. HULUGALLE and in Tamil by MR. COOKE. The weekly programme allowed 4 mornings for fieldwork, 2 for notebook work and 5 afternoons for lecture and demonstration work. The average age of the men was 34 years. The theory work was in consequence reduced to a minimum and the demonstrations proportionately increased. With slight alterations, the work covered averages two-thirds of the "One Year's Course" of the School Prospectus.

5. The work of the course groups itself into two divisions,—Fieldwork and Classroom work. The fieldwork comprised the cultivation of plots of land and demonstrations in Planting and Horticulture. In the classroom were given lectures in the science of agriculture closely correlated with the work done in the field. The work covered may be summarised as follows:—

FIELDWORK 1. PLOTS. 52 2-hour periods were employed in the experimental cultivation of crops. Each headman was allotted 1/16 acre and the crops cultivated were: Sorghum, Maize, Kurakkan, Bandakka, Brinjal,

Chillies, Lima Bean, Mè, Dhall, Mun, and Curry Stuffs. 2. PLANTING. 26 2-hour periods were devoted to demonstrations on the cultivation of,—Paddy, Coconuts, Tobacco, Orchard and Vegetable crops, Green Manures, Vanilla, Tea, Coffee, Cacao and Rubber. 3. HORTICULTURE. 26 2-hour periods were given to,—Nurseries, Pot-culture, Sowing, Cuttings, Layering, Grafting, Inarching, Budding, Pruning, Planting and Transplanting, Packing and Transporting plants and seeds, Storing, Felling, Making of paths and roads.

LECTURE WORK.—The lecture work was largely interspersed with demonstrations and arranged so as to go hand-in-hand with the operations in which the headmen were engaged in the field. It was divided into 5 sections as follows,—1. Soil and Manures. 2. Plant, Economic Products, and Plant Diseases. 3. Animals and Pests. 4. Farm Implements, Buildings, and Chain Surveying. 5. Co-operation and Accounts. The following topics were included under the above:—Tillage, Soil Organisms, Dry Farming; Farmyard, Green and Artificial manures; Improvement of cultivated plants; Diseases of cultivated plants; Foods and Feeding of Animals, Common Ailments, Improvement of stock, Dairying; Control of Pests; Relative merits of Native and Imported Implements; the Formation and Working of Co-operative Credit Societies. In all 220 hours were devoted to classroom work.

6. The Tamil Headmen were given a mid-term vacation of one fortnight in August to allow them to return to their homes for harvest. The work lost in this interval was made good during the School vacation in October. Packets of Vegetable and Curry Stuff seeds were distributed to headmen during the vacation and were used for sowing at home and in the villages, in the hope that this would serve to encourage local cultivation of suitable food crops and as useful demonstration work. The reports received of this vacation work were highly satisfactory.

7. The men evinced a keen appreciation of the nature of the instruction given to them and engaged in all the work prescribed with eagerness. Special mention is made of the high standard reached by them in all field operations, particularly on their plots which were inspected and commended by the Hon. the Government Agent, C. P., on his visit on September 13th. Much good is anticipated as a result of the course; and it might here be recorded that already three new Co-operative Credit Societies have been started by these headmen in their districts.

8. Thirteen headmen completed the full course creditably and have earned certificates. Two others have been granted partial certificates. One failed to complete the course or take the final examination. Government has approved the award of two silver and three bronze medals to the first five candidates in recognition of the high standard of results gained by them. A third silver medal, presented by the Principal, has been awarded to the sixth for the best work in the field plots.

ST. L. H. DE ZYLVA,
Registrar, School of Tropical Agriculture.

Peradeniya 10th January, 1918.

RESULTS OF HEADMEN'S COURSE, SCHOOL OF TROPICAL AGRICULTURE, PERADENIYA, MAY-DECEMBER, 1917.

Province	Names in order of merit on results of course.	Admitted.	Awarded.
C. P.	H. B. Rambukwella, Korala, Kandy District ...	14-5-1917	Silver medal & certificate.
E. P.	K. U. Sinnetamby, Police Headman, Trinco. District ...	4-6-1917	Silver medal & certificate.
Uva	M. B. Wettewe, Additional Native Writer, Badulla Kachcheri	14-5-1917	Bronze medal & certificate.
C. P.	D. M. Punchirala, Arachchi, Kandy District ...	14-5-1917	Bronze medal & certificate.
E. P.	K. Subramaniam, Police Headman, Trinco. Town ...	4-6-1917	Bronze medal & certificate.
N. W. P.	*G. M. D'Silva, Police Headman, Madampe ...	14-5-1917	Certificate
N. W. P.	T. B. Wijesuriya, Arachchi, Kurunegala District ...	1-6-1917	do
N. W. P.	D. M. Kiribanda, Arachchi, do do ...	1-6-1917	do
Uva	C. B. Galagoda, Korala and Inquirer, Badulla District ...	14-5-1917	do
W. P.	M. A. Baron Perera, Police Vidane, Colombo District ...	1-8-1917	do
S. P.	D. C. Abeywickrema, Vel Vidane, Galle District ...	5-7-1917	do
W. P.	P. C. Chandrasekera, Police Vidane, Colombo District .	1-8-1917	do
W. P.	G. Don Abilias, Police Vidane, Kalutara District ...	21-8 1917	do
N. P.	A. Coomaraswamy, Police Vidhan, Jaffna District ...	14-5-1917	Partial certificate.
C. P.	S. B. Galagoda, Arachchi, Kandy District ...	14-5-1917	Partial certificate.
W. P.	J. D. D. Jayawardene, sometime Police Headman, Kalutara District. Did not complete course or take Final Examination		

* Silver Medal presented by Principal for Plot Work.

OPENING OF AGRICULTURAL SCHOOLS IN THE MADRAS PRESIDENCY.

The HON'BLE MR. P. SIVA RAO:—"Your Excellency, I need not take very long over this resolution. The resolution reads thus:—

"XXII. 'This Council recommends to His Excellency the Governor in Council that agricultural schools may be opened in some convenient centres in the Presidency.'

"The subject is one of paramount importance. It is impossible to exaggerate its usefulness in a country where almost the entire population live on agriculture. In fact agriculture is the one industry which maintains the millions of India and in this matter there are infinite possibilities before the country. It is highly essential that the average cultivator should be made familiar with the modern and scientific methods in agriculture.

"The Agricultural College at Coimbatore which is now supplying the highest scientific needs of the country cannot go far to popularize scientific agricultural education. We are aware that the Government have the best interests of this department at heart and are already taking steps to spread agricultural education by leaflets and other ways and also by the opening of the additional agricultural farms throughout the Presidency. We are highly thankful to your Excellency's Government for their kind endeavours in this matter. In October, 1913, the question of the curricula of studies in the Agricultural College at Coimbatore was raised by the Director of Agriculture. Then he proposed a revision of the courses of studies in the college—one of two years' duration for agriculturists and another of four years' duration for candidates for diploma for Government service. The fact is, that the instruction given at Coimbatore is high and is given in English, and practically deters even willing students from completing their course on account of their deficient knowledge of English, and the gentlemen farmers whom it originally intended to benefit have not been so benefited. In December, 1913, the Agricultural Conference met at Coimbatore and approved of the two years' course at Coimbatore. This proposal for the opening of the agricultural schools in some convenient centres of the Presidency practically gives effect to the recommendations of the Agricultural Conference. Instead of starting the proposed bifurcation of courses in the Coimbatore College itself the Government may open schools in which the two years' course is provided and the instruction is imparted in the vernaculars so that these schools may serve as feeders to the college. The students who show special aptitude for highly scientific education may pursue their studies further in the college after completing their courses in the proposed schools. Besides Coimbatore College is situated in one corner of the Presidency and is not easily accessible to all the students coming from the various districts. It is highly desirable therefore that the Coimbatore College should fulfil the purpose of a central institution and the proposed schools which provide for a lower course of instruction should be within the reach of all. It is equally expedient to open these schools in convenient centres in the Presidency as the local conditions vary; and practical agricultural education in order that it may be effective should be with strict reference to local conditions. There are also considerations of distance and expense for undergoing a course at Coimbatore which can be avoided by opening schools in convenient centres.

"The present Agricultural College is very popular and the growing demand for the agricultural institutions is tested by the fact of the

number of applications received for entry into the college and increased interest shown by the cultivators in attending cattle shows and competing therein and also in visiting model farms. Only a limited number of applications could be admitted under the present state of accommodation in the college. One feature of the proposed schools should be that they should impart instruction in elementary agriculture in the vernacular. I think that vernacular should be made the medium of instruction in the lower standards.

"Mere issue of leaflets and circulars will not do. The schools should diffuse agricultural knowledge throughout the country.

"In the report on the introduction of improvement into Indian agriculture in the year 1909 it is stated: 'In many countries one of the best means of bringing practical information to the cultivators of the land has been the issue of leaflets and circulars couched in the popular language. In India, where the standard of education is lower than most western countries, the value of such publication is more problematical but they have been used with success.'

"At the Agricultural Conference held at Coimbatore the resolution was passed:—'The Board should recommend for the consideration of the Local Governments the importance of the schools on the model of vernacular agricultural schools in Bombay.'

"It is futile to teach agriculture in primary schools It cannot be appended to any system of general education. The schools should always be attached to some farms. There should be technical institutions solely devoted to the study of agricultural education.

"The HON'BLE SIR JOHN ATKINSON when this resolution was moved in the Legislative Council in May, 1914, stated in his reply: 'The object of these proposals have the full sympathy of the Government. They deserve and it is their most earnest desire to promote not only the study but the practice of agriculture in every way they can. The present difficulty is the want of trained and educated staff. The staff of the Agricultural department is small. It is certainly inadequate to the staffing of schools. I think it is highly probable that in due course we shall follow the example set in Poona. At Poona there is a regular agricultural school. It is a residential school with hostels and the pupils live in it. It will be the endeavour of the Government at the very earliest moment to take into consideration whether we ought not to follow in the footsteps of the experiment that has been made at Poona.' Further, he stated: 'I can only say that the Government hope to be able to open schools when they have increased the staff.'

"His Excellency the President said on the same occasion: 'I can assure the Council that this Government are entirely desirous, as SIR JOHN ATKINSON has said, of going ahead in this matter, so far as funds permit and so far as the trained men can be obtained.'

"The Agricultural Educational Conference met last on the 18th of June, 1917, at Simla, and in his opening speech SIR CLAUDE HILL stated: 'The ultimate goal, in fact, which I put before myself is one agricultural high school in each district with several lower grade schools in the district attached perhaps to demonstration farms leading up to the high schools.'

"The question considered by the conference was 'Whether it was desirable to lay down as the ultimate goal the establishment in each district of one agricultural school of the status of high school and of one or more of agricultural schools of the status of the middle or Anglo-vernacular schools leading up to the high school.' In explaining his position in regard to this question, SIR CLAUDE HILL stated that there was no other country in which agriculture bulked so large in the daily life, hence he thought that it would be but right to have a scheme like the one contemplated in question as a goal. In the course of the discussion MR. WOOD, the representative of Madras, stated that in Madras they had pinned their faith in agricultural

matters to the belief in demonstration farms and any attempt to start schools for agriculture would act as a handicap on their present programme of work. All that he would like to see done under the present circumstances was to assist in giving an agricultural tint to primary education. After an elaborate discussion the conference unanimously resolved that it was desirable to start one or more agricultural schools in rural districts usually near demonstration or experimental farms but it was divided as to advisability of having any agricultural high school. MR. WOOD did not of course subscribe to this. He gave out his belief that in Madras special attention for some time to come should be given to demonstration farms the interests of which would suffer if the men who passed out from the Agricultural College should be drafted away to serve as teachers in agricultural schools.

'The last conference held at Pusa was of opinion that it was not possible to teach agriculture directly in primary schools though it re-affirmed the desirability of adapting rural education to rural needs. SIR JOHN ATKINSON in his reply already referred to stated: 'The fact is that it is impracticable—it is impossible—to teach agriculture as a course in primary schools.' The same Honourable Member quoted MR. MACKENNA on the subject as saying: 'There is now a large consensus of opinion that agriculture as such is not a fit subject for teaching in schools. It is not, in fact, a subject at all and rural education should be as general as agricultural education should be technical.' The Honourable Member further stated : 'I am told by everybody who knows that the subject of agricultural education in primary schools is an anathema.'

"With these words, I wish to commend the resolution to your acceptance."

The HON'BLE MR. K. R. V. KRISHNA RAO :—"My Lord, I beg to second this resolution. A similar resolution was brought before this Council in 1914 and then it was said on behalf of Government by SIR JOHN ATKINSON that, as soon as the requisite staff was available, Government would be only too glad to open such schools. Your Excellency was also kind enough to express all sympathy with this matter and I believe that conditions now are more favourable and the object of my Honourable Friend MR. SIVA RAO in bringing this resolution at present is to remind the Government about the necessity of opening agricultural schools in suitable centres in the Presidency. With these words, I second this resolution."

The HON'BLE DIWAN BAHADUR P. RAJAGOPALA ACHARIYAR :—"Your Excellency, I am by no means certain that conditions have greatly improved. I do not know whether the Honourable Member means that we have more funds at our disposal or more staff than we had two or three years ago. But that is not the point that I wish just now to bring to the notice of this Council. The Honourable Mover referred to the recommendation made by the conference held at Simla in June 1917 on the subject and the fact that the Madras delegate MR. WOOD qualified the acceptance of that recommendation, so far as Madras was concerned, by expressing the view that concentration and demonstration were more desirable than the establishment of schools. The proceedings of that conference have come to us from the Government of India for consideration and the question has been referred to the Director of Agriculture. Till the Director has gone into the matter and till he submits a report, it is not possible for me to commit the Government to any expression of opinion in regard to the subject and all that I can say now is that the whole question will be carefully considered. I promise that what has been said by the HON'BLE MR. SIVA RAO and the HON'BLE MR. KRISHNA RAO will be considered. In view of that I hope the resolution will not be pressed."

The HON'BLE MR. P. SIVA RAO :—"I beg to withdraw the resolution."

With the permission of His Excellency the President, the resolution was then withdrawn. PROCEEDINGS OF THE LEGISLATIVE COUNCIL OF MADRAS, 21st November, 1917.

CO-OPERATION.

PROGRESS OF CO-OPERATIVE SOCIETIES IN BARODA.

The Report of the Registrar of Co-operative Societies, Baroda State, on the working of Co-operative Societies for the year 1915-16 contains as usual an interesting account of the work done during the year.

Societies.—The societies are grouped in the following classes, viz.: Central Banks and Banking Unions : Agricultural Societies, Credit and Non-Credit and Non-Agricultural Societies. Credit and Non-Credit have increased to 323 from 307 last year. The increase is not so great a number but considering the adverse circumstances of the year and that the Department has paid more attention to consolidation rather than the expansion the increase is satisfactory.

Of these 3 come under the first group, with no increase for the year, 295 under the second group with an increase of 9 societies over that of last year and 25 under the last group with an increase of 7 societies.

Out of the 295 Agricultural Societies, 292 are Credit Societies and 3 are Non-Credit Societies. Of the latter, two are milk supply societies and one is an Agricultural Machinery Society for irrigation purposes. A few of the Agricultural Credit Societies have transacted distributive and purchasing business for their members.

Of the Non-Agricultural 22 are Credit and 3 are Non-Credit Societies. Out of the Non-Credit Societies, one was a Co-operative Milk Depôt and the other two were Stores.

Members.—The total number of members of all the societies at the end of the year was 10,620 which is an increase of 1,353. Of these 244 are members of Central Banks and Banking Unions, 8,647 are members of Agricultural Societies and 1,729 belonging to Non-Agricultural Societies. The average number of membership has increased from 30·15 in the past year to 32·50 in the year under report.

Capital.—A satisfactory progress has been made in the working capital of Societies. The working capital of the year under review is Rs. 954,141 as against Rs. 800,280 last year. This works out an average of Rs. 2,944 against Rs. 2,607 last year—an increase of Rs. 337. There is a similar rise in the working capital per member from Rs. 86 to Rs. 87.

Deposit.—At the end of last year there was only Rs. 237,827 under this head to the credit of members in the societies and at the end of the year under review this sum rose to Rs. 319,395—a very satisfactory increase. These three items which constitute a proper criterion of improvement thus show an appreciable increase.

Profit—The net profits earned by all the Societies has also increased to Rs. 39,576 from Rs. 35,221 in the previous year.

Reserve Fund.—A sum of Rs. 29,006 has been added to the Reserve Fund bringing the total to Rs. 98,591. At the end of previous year this

stood at Rs. 69,585. A considerable increase has also been made in the matter of loans and the amount thus given exceeded the figures of last year by Rs. 46,349.

Other Resources.—Of the various sources of the working capital the next important item is the loans from Government of a sum of Rs. 228,847 which goes to form 23'9 per cent. of the total working capital. But it is interesting to observe that this amount is not given out to societies actually as loans but a very great portion of it is deposit made by the Accountant-General of the State of the Surplus Balances of the Government funds at current rate of interest, thus getting the people to place confidence in these societies.

Other matters contained in the report such as disputes and litigation, audit and inspection, Acts, rules and by-laws, etc., are of a general nature and are not of much importance to be reviewed here.

N. W.

A CO-OPERATIVE GRAIN BANK IN BOMBAY.

In the latest issue of the BOMBAY CO-OPERATIVE QUARTERLY (VOL. 1 No. 3) an account is given of a Co-operative Grain Bank at Kodni, a remote village in the Belgaum district in the Bombay Presidency. There are 2,000 inhabitants in the village who are not in a prosperous condition and are plunged in debt. They borrow from local money lenders on the security of landed property for cultivation of their small patches of land with "jowar, groundnut, tobacco which go to form the chief crops and sugar cane. The staple food crop of the village is jowar."

The Bank was first started in the form of a grain store in 1896 for the purpose of supplying grain for food of needy cultivators and others at cheap and easy rates, the necessary grains being collected by levying almost voluntary contributions. The Bank began work with 17 maunds of grain in the first year which increased to 30 in the succeeding year. At about this time the Bank also received a sum of Rs. 20 realized by the sale of a bull. Since then the Bank started its work with transactions both in kind and money.

In 1906, ten years after its inauguration, the Bank was brought under the Co-operative Credit Societies Act by registration. At this time the capital of the bank had accumulated to about Rs. 1,000 in kind and cash together, thus showing that the Bank worked on sound and business-like principles.

It is now eleven years since its inauguration and the Bank has made rapid progress and it can now safely be said that it is the largest and best managed village grain bank in the Presidency. Its founder takes an interest in the institution. It has a membership of 147 persons. Its working capital is Rs. 5,400 both in grain and money of which Rs. 1,500 represents the value of the grain. It has a Reserve Fund of Rs. 2,450 which is its owned capital made out of the accumulated profits made by the Bank.

The Bank lends out grain at 20 per cent. interest and money for domestic purposes and agricultural needs at $9\frac{3}{4}$ per cent. per annum. But its profits were all not earned in this way out of interest. The Bank used to sell extra grains—what is left after the requirements of the members were met, when favourable opportunities occurred. In this way the Bank earned much profits and accumulated more cash. It is feared that in the course of time the real nature of the origin of the grain bank which was meant for transaction in kind will be shadowed and money transactions become more promiscuous.

The Reserve Fund is held partly in cash, viz. Rs. 2,000 and partly in grain value Rs. 450. The remaining capital is made up of deposits by members which amount to Rs. 600, Rs. 2,000 belonging to the Panches, and a loan of Rs. 720 from Government.

The rule of the Bank is that cash loans should be repaid in cash and loans of grain in kind. Grain is lent out to members just before the sowing season and repaid after the crop is gathered, thus renewing the stock of grain annually which prevents the deterioration of seed.

The Bank proposes to erect its own grain cellar with a capacity of holding the maximum quantity of grain required by the members in any one year.

The affairs of the Bank are managed by the Committee which consists of all the leading castes of the village in strict conformity with the by-laws of the Bank. They work with a co-operative spirit. The accounts of the society are as a rule well kept and it maintains a very high standard. The Bank has not lost, so it is said, a grain of what was lent ever since the establishment of the Bank.

The writer of the article sounds a note of warning to those intending to open grain banks. As the storing of grain for long periods renders the grain liable to deterioration the necessity of renewing the stock by sale from time to time as the Kodni Bank has done is emphasised.

N. W.

PROGRESS OF CO-OPERATION IN MADRAS.

The annual report of the Registrar of Co-operative Societies, Madras, on the working of Co-operative Societies in the Presidency of Madras for 1916-17 is to hand and shows a considerable improvement within the year in the matter of higher co-operation. The Madras Central Urban Bank Ltd., has been converted into a Provincial Bank and the Vizagapatam District Supervising Union into a Banking Union and the number of Administrative Unions has been increased to 56 which at the present time supervise the work of 1,758 local societies.

Societies. 421 societies have been registered during the year and the total number of societies has increased to 2,216. The registration of 6 societies has been cancelled. These are 1 Provincial Bank, 13 Central Banks, 224 non-agricultural societies and 1,921 agricultural societies.

Members. The number of members of all the societies (excluding 57 unions and the liquidated societies) was 163,121 as against 136,286 in the previous year showing an increase of 26,835 members. The average number of members per society was 74 against 76 in the previous year.

Capital. The working capital of all the societies was Rs. 20,498,851'00. as against Rs. 16,888,833'00 in the previous year. This is composed of the following items. Share capital Rs. 2,048,564'00. Deposits of members Rs. 7,284,185'00. Loans from other societies Rs. 9,043,269'00. Loans and deposits from non-members Rs. 1,264,458'00. Loans from Government Rs. 9,795'00 and the Reserve Fund Rs. 848,580'00. The loans from Government have only been given to agricultural societies. The amount standing to the credit of non-members in the previous year was Rs. 5,576,503'00. The decrease was due to the stringency of the money market due to the War. Following figures speak for themselves as to the volume of business done :— Demand Rs. 8,066,429'00; Collection Rs. 6,397,324'00 and the balance outstanding was Rs. 1,629,105'00. The interest collected during the year was Rs. 1,450,075'00.

Reserve Fund. The total amount to the credit of the Reserve Fund was Rs. 848,580'00. The amount carried to the Reserve Fund during the year under review was Rs. 114,132'00. Of this the sum of Rs. 743,833'00 has been invested.

N. W.

GENERAL.

TEA IN INDIA.

The twenty-second Report on the Production of Tea in India deals with the production in the calendar year 1916, and also as regards trade figures, with the fiscal year 1916-17.

The year under review was not so prosperous as its predecessor, when a record outturn and a record price level were reached. Nevertheless, owing to increased acreage and scientific manuring, the outturn was larger than in any previous year except 1915, and the average price was only three pies less per lb. than the record of that year.

The total area under tea in 1916 was 650,800 acres, which is 2·5 per cent. greater than that in the preceding year. The area abandoned in the year was 4,600 acres, while the new extensions (including replanting in areas abandoned in previous years) amounted to 20,500 acres. Thus the net increase during the year was 15,900 acres. The figures are for the most part those reported by planters. In the case of those plantations for which figures are not so reported, estimates have been prepared by local officers. Special efforts were, however, made to procure returns direct from non-reporting gardens, and these efforts have so far been successful except in Southern India. The cultivation of tea in India has been mainly concentrated in tracts where a heavy rainfall and a humid and equable climate permit of repeated flushes and pluckings of the leaf. Eighty-five per cent. of the total area under tea in India lies in Assam (in the Brahmaputra and Burma Valleys) and the two contiguous districts (Darjeeling and Jalpaiguri) of Northern Bengal. The elevated region over the Malabar Coast in Southern India (including the native state of Travancore and the districts of Malabar, Nilgiris, and Coimbatore) contains over 11 per cent. of the total.

Of the total area of 650,800 acres, for which either returns or complete estimates have been received, 601,400 acres were reported to have been plucked during the year, as against 584,900 acres in the preceding year. Of the remaining 49,400 acres, the plants were either too young to be plucked or were not plucked at all.

The total number of plantations was 4,486 in 1916, as against 4,437 in the preceding year. In Burma, where tea plants are grown scattered in the jungle, each village tract having tea plants has been taken to represent one plantation. The plantations vary greatly in size in the different provinces. In Assam 786 plantations are reported to have a total area of 389,200 acres under tea in 1916, that is, an average of 495 acres per plantation. In Bengal the average size of 301 plantations is 551 acres and in Travancore the average of 107 plantations is 394 acres. In Madras, the United Provinces, and

Bihar and Orissa the average is much smaller, being about 170 acres, 131 acres, and 98 acres respectively. In the Punjab, where tea cultivation is conducted on a small scale, the average area is about 3 acres. These figures, which refer to the year 1916, relate only to tea-bearing areas and do not include the area in the occupation of planters but not under tea cultivation.

The total production of both black and green teas in 1916 is reported to have been 368,437,000 lb. (excluding Burma) divided between the different parts of India as shown below :—

		1916. lb.		1915. lb.
Assam	...	242,185,000	...	245,386,000
Bengal	...	92,645,000	...	89,526,000
Southern India	...	29,324,000	...	31,610,000
Northern India	...	3,883,000	...	4,876,000
Bihar and Orissa	...	400,000	...	293,000
Total	...	368,437,000		371,691,000

Black tea represents 365,760,000 lb. The net decrease as compared with the preceding year amounts to about 3 million lb. or 0·9 per cent. It should, however, be borne in mind that these figures cannot be taken as entirely accurate, for, as already stated above under "Area," (page 120), estimates had to be made for as many as 57 gardens for which returns were not furnished by planters. It is noticeable that, while the area under cultivation has increased by 21 per cent. in the decade, the increase in production has been one of 51 per cent. Burma is excluded from these calculations because the produce of the Burma tea gardens is almost wholly converted into *letpot* (wet pickled tea), which is eaten as a condiment. In 1916, 563,300 lb. of *letpet* were manufactured as against only 5,300 lb. of leaf tea (black).

The average production of tea per acre varies very greatly in the different districts. The highest production in the year was in Lakhimpur (Assam), namely, 788 lb. per acre, and the lowest in Garhwal (United Provinces), namely, 52 lb. The average production in the whole of India (excluding Burma) was 614 lb. per acre plucked, as against 637 lb. in the previous year. At the beginning of the season weather conditions were somewhat disappointing, and it was not until the season had considerably advanced that conditions became favourable for the growth of the crop. Exceptionally good yields were obtained, except in Cachar and Sylhet, during August and September, but from then onwards the outturn steadily decreased. In parts of Cachar heavy floods occurred during October and greatly affected the outturn at the time, although it resulted in some very heavy flushes at the close of the season. Intensive cultivation undoubtedly accounts for the exceptional outturns again obtained during the latter part of the year, which, although not quite up to those of 1915, were exceedingly heavy. As regards the quality of the tea manufactured, a leading tea firm aptly summarises the position as follows:—

"Quality has been of useful standard throughout, though the available quantity of really good tea has been less than usual.

Early arrivals from Darjeeling were good and quite a number of attractive second flush teas were seen, but the proportion of really fine tea proved small. Terai made some unusually nice teas at the start. Dooar's quality was about up to average. Some fair autumnal teas were seen, but the quality was limited. A useful though irregular selection came from Assam. Fine second flush quality tea was not in very great supply, and the character of offerings at the close was a little disappointing. Cachar and Sylhet again made a large quantity of good sweet liquoring tea. Early manufacture was, however, not good, and the floods experienced during the latter part of the year to a great extent accounted for some unusually poor teas at the finish."*

The figures of production given above include both black and green teas. The difference between the kinds of tea arises from the different methods of preparation. Briefly, the distinction is that the process of fermentation, which gives to black tea its colour, is avoided or arrested in the case of green tea. The total quantity of green tea reported to have been manufactured in the year under review is 2,677,000 lb. as compared with 3,043,000 lb., in 1915 and 3,050,000 lb. in 1914. Bounties were paid on green tea from the Tea Cess Fund up to March, 1909, but since that date no bounties have been paid and the production continues to decline.—REPORT ON THE PRODUCTION OF TEA IN INDIA IN THE CALENDAR YEAR 1916.

THE CULTIVATION OF PEPPER (PIPER NIGRUM) IN MULLAITTIVU DISTRICT.

For many years the cultivation of the pepper vine has been carried on in Mulliyavalai and Kanukerni villages in the Mullaittivu district. Almost in every living compound these vines are seen climbing on one or two Palmyra or Coconut palms and these villages are said to produce from 300 to 500 measures of pepper annually. The cultivators reserve a portion of their crop for the use of their family and sell the remaining portion at 50 to 75 cents per measure, mostly to Jaffna traders, who buy for medicinal purposes as this pepper is considered to be of a better quality than the imported one.

The soil on which these vines are cultivated is a sandy loam of a poor quality and no manure is applied at all.

These vines are propagated by cuttings obtained from the terminal shoots and the planting commences about the months of July-August.

After selecting the tree on which these vines are to climb up, the ground close to the trunk of the tree is raised a little so that the bed can be well drained and 3 to 4 cuttings are planted around the tree and watered at intervals during dry weather until the vines are a year old.

About the third year of planting the flower spikes appear in the months of October-November and the crop is produced from March to May.

As soon as the berries are ripe and begin to turn reddish they are gathered and kept in a basket for about 3 days and then dried in the sun for another 3 days when the pepper is ready for the market.

V. RAMANATHAN,
Agric. Instructor, N.P.

Vide MESSRS. J. THOMAS & CO.'S ANNUAL REVIEW, 1916-17.

NOTES ON PEASANT AGRICULTURE IN GRENADA.

A very high standard was attained in the work done by the peasant proprietors who competed under the Prize Holdings Scheme for bearing cacao cultivation. Meritorious work was performed by 191 competitors, who owned holdings of 5 acres and under in the parishes of St. David, St. Andrew, and St. Patrick. Marked progress was made in draining and mulching, and the more general use of pen manure. Satisfactory progress has also to be recorded in the appreciation of the services of the Agricultural instructors by the peasants.

A satisfactory feature to be noted is that many districts which were quite indifferent have during the year come into line with lively interest. Although satisfactory progress has been made during the year, only a small percentage of the peasant proprietors have been affected directly. These, however, will be as leaven to the majority, and their holdings are good demonstration plots as to the success which can be achieved by the best work.

It cannot be said that any improvement has yet been made in the methods of growing cotton in Carriacou. The crop has been very unsatisfactory, although the season has been favourable. The cause of the falling off is entirely due to want of tillage, and draining, lengthy ratooning, and lack of seed selection.

The instruction and demonstration work done by the Department during the year has awakened a larger measure of interest than was at first anticipated. With the additional stimulus of a Prize Holdings Competition in 1917-18, it is hoped to induce the peasants to give some attention to the improvement of their cotton.

The greatest obstacle in the way of improvement in cultivation methods among the peasants in Carriacou is the unsettled and migratory male population, which is located in the island in comparatively small numbers during the planting season. Another retarding factor is the metayer or share system, which is employed to a considerable extent by even the smallest peasant owners.

The peasantry in Grenada are keen on growing sugar-cane, and immediately a sugar factory is erected all the available land in its vicinity is taken up and planted. It is regrettable, however, that the cultivation methods employed leave much to be desired, and a rather low yield is the general rule.

The production of garden vegetables such as cabbages, carrots, turnips, chive, thyme, shallots, etc., for the supply of the whole island, is practically confined to one district, from Snug Corner to Vendome. The supply is kept up with fair regularity, and is taken weekly to market in the several parishes. Good carrots and turnips are produced, but there is room for improvement in other lines.

There has not been much improvement in the cultivation of the peasants' provision gardens, although some progress has been made during the past year under the prize Holdings Scheme in the parishes of St. George, St. Mark, and St. John. The competition in provision gardens is being set on foot in the other parishes during the 1917 season.—Rept. on the Agric. Dept., Grenada, 1916-17.

THE ORIGIN AND DISPERSAL OF THE COCONUT.

In the PHILIPPINE JOURNAL OF SCIENCE (Botanical Section)—for January this subject is dealt with by MR. O. BECCARI who combats the theory enunciated by MR. O. F. COOK, viz., that America is the home of the coconut and that its dissemination was effected by navigators.

He favours the idea that it is a native of the East Indian Islands, including Ceylon, or of land that once existed between Africa and India, and that the nuts were carried to the Pacific Isles by ocean currents.

He refutes COOK's dictum that the coconut existed in America before its discovery by COLOMBUS, and that the fruits were not and cannot be disseminated by sea water but they need the help of man for their propagation.

COOK would appear to have made some strange statements which go to show his unfamiliarity with the habits of the palm. For instance, he mentions that ripe nuts in falling from a tree are so injured as to be unfit for germination; again that the palm seldom grows within reach of the waves.

Incidentally reference is made to the extraordinary thickness of the pericarp of the nut, generally considered a provision for favouring dispersal by water or for deadening shock when it falls. MR. BECCARI would add to these that it is a condition for protecting it against damage from such predatory agents as *Birgus*, the robber crab.

BECCARI considers the coconut palm a halophilous (salt-resisting) plant, specially suited to tropical sea coasts and to oceanic dispersal, and that Coral Islands are best adapted to its spontaneous reproduction.

The following extract referring to the value of salt to the coconut will be read with interest by those who advocate the application of salt to palms on inland plantations :—

A chemical analysis of the ash of the coconut palm shows that all its organs contain chloride of sodium in considerable quantity; this salt, indeed, after the salts of potassium and of lime and the phosphates, being their most abundant constituent; it is even more abundant than silica, which in the state of crystals is found to be especially abundant in the leaves.

According to the summing up of PRUDHOMME, a plantation of 1 hectare of the coconut palm annually draws out of the soil 120 kilograms of marine salt. And from FERGUSON's report we learn that an adult plant requires each year 1·34 kilograms of chloride of sodium. Salt, therefore, is considered an important manure for the coconut palm—far more than the quantity found in its ashes appears to demonstrate.

From the same source I learn that DOCTOR GARDNER, to show the value that the Brasilians attribute to salt as a fertilizer for coconuts, states that "a man would walk many miles for it, pay high for a load, and then apply it to a single tree." Elsewhere, it is stated that sea weeds and the ashes of plants that contain much salt are used as manures for the coconut palm. FERGUSON also states (p. 142) that the Sinhalese "invariably throw a little salt into the holes before they place the coconut plants in them." And on page 111, speaking of a new plantation of coconuts which is being made

inland and at a distance from the sea, he says: "It is customary to throw a considerable quantity, as much as half a bushel, of salt into the hole which receives the coconuts."

PRUDHOMME, writing of the toleration of the coconut palm for marine salt, asks if marine salt should not be reckoned among the fertilizers to be administered to this palm, as it seemed to him, that instead of merely tolerating it, the coconut had a real preference for this salt. The excessive toxicity of sodium chloride for plants is well known; the coconut palm, however, is one of the few that can live on a salt soil. For that reason I am not able to understand how a plant endowed with such high hereditary halophitism—which, therefore, not only tolerates, but actually prefers, a salt soil and, moreover bears fruit so constituted as to be, as SEEMAN writes, "often tossed about the ocean for months without losing its germinating power from the effect of salt water"—can have been plasmed or brought into existence in a region remote from the sea. C. D.

INDIGO, NATURAL AND ARTIFICIAL.

Some idea of the extent and importance of the dyeing industry may be formed when it is stated that in England alone some £2,000,000 worth of dyes are consumed annually, which are essential to industrial products valued at something like £200,000,000. Of dyes of this value, barely one-tenth was produced in England before the outbreak of War.

In Egypt the consumption of coloured dyes is comparatively small. The use of indigo is somewhat extensive, in normal years (e.g., in 1913) Egypt imported 574 metric tons of indigo to 292 m. tons of other aniline dyes.

On the outbreak of War the supplies from Germany stopped. The Egyptian Government recognising the difficulties and distress among the dyers in Egypt purchased from the Prize Court some quantities of artificial indigo and re-sold them at cost price to the dyers.

In Egypt there is even in normal times, when the synthetic product is available a certain demand for the natural indigo supplied by India. This is used for certain special purposes as for Government uniforms and finer class goods. The difficulty about the natural product is that it cannot be obtained in the same amount of regularity in degree of strength. Unlike the synthetic product, too, it is not ready for immediate use as it has to undergo fermentation in the dyeing vats for three or four days or even a week before it is reduced and rendered soluble. The synthetic indigo imported into Egypt was of a very high quality containing about 40 to 50% paste. The lower grades containing about 20% paste is used chiefly in the Far East.

These notes are obtained from an article by KINGSFORD on "Dyes, Natural and Artificial" written for the AGRICULTURAL JOURNAL OF EGYPT Vol. VII., pp. 134-149. The writer is a member of the Commission of Agricultural Commerce who was specially delegated to superintend the disposal of dyes acquired by the Egyptian Government.

He considers that taking advantage of Indian experience and improvements in cultivation, indigo growing and manufacture might be carried out profitably in the Sudan. The Sudan holds an advantageous position in this respect as it is not troubled with the wet and rainy seasons that in India cause a deterioration of the quality of the crop. The previous attempts in Egypt were short-lived as there was "absence of expert supervision and the indispensable care necessary for the extraction process."

One of the newer varieties successfully experimented with in India, *Indigo Sumatrana* had been tried by the Director of Agriculture, Khartoum, and "there does not appear to be any doubt that the crop would thrive in the Sudan." A difficulty in Egypt will be owing to the fact that labour and land values exceed those in India. This may prevent the opening out of extensive tracts of land under indigo.

It is well established now that the general lines of organization needed in producing natural indigo profitably so as to compete with the synthetic product is a wholesale reduction in the expenditure on raising and preparing the product for the market combined with cultivation on an extensive scale so as to meet a narrower margin of profit.

Research work at Pusa has made considerable progress towards laying down the general lines to take on such matters as (1) seed selection and seed supply, (2) cultivation with a view to larger yields of plant and colouring matter, (3) the preparation of the product in a standard form of high purity.

Of some 300 species of *Indigofera*, *I. tinctoria* and its varieties have for a long time occupied the most important place. More recently, *I. arrecta* has become popular. This originated in Abyssinia and Natal. Seed was introduced into India from those of wild plants grown in Java, hence its name Natal-Java Indigo. This species is believed to be less adversely affected by wet weather. HOWARD recommends that under monsoon conditions obtaining at Bihar the type of plant to select is a rapidly-growing, early-flowering, bushy form with a large proportion of lateral roots concentrated near to the surface. The seed must be planted in well-drained soil and the surface-soil constantly cultivated.

The leaves are richest in *indican* when the plant is ready to flower. The manufacturing season in India commences about the middle of June. A second cutting is obtained two or three months later. The plants are cut early in the morning, often before day break, and brought to the factory in carts. Each factory deals with plants from within a radius of four or five miles. The average amount of indigo produced on a manufacturing scale from 100 lb. of green plant is about four ounces. "An acre of land with an average crop yields about fifteen pounds of good Bengal indigo."

A small factory in India consists of six steeping vats and two beating vats. The amount of green plant put into a vat of 1,000 c. ft. capacity varies from 11,000 to 15,000 lb.

An abundant supply of good water is indispensable; "every pound requires 300 to 500 gallons, and upon its quality largely depends the success of the operation." Water containing organic matter in suspension or solution gives bad results. Rain-water is generally collected in tanks for this purpose.

The plants are steeped from nine to fourteen hours depending upon the temperature of the water and climatic conditions. Two or three hours are required for the operation of beating. This in modern factories is done by a wheel consisting of a shaft armed with three sets of spokes.

After beating the indigo "fecula" is allowed to settle and the supernatant liquid ("*seeth* water") is run off; the "fecula" is elevated into a steam injector and heated (not boiled) up to a temperature varying from 190° F. to 212° F. This causes the indigo particles to settle more quickly, purifies the product, and prevents putrefaction. After this the pulp is dressed and dried and packed in chests.

H. L. VAN B.

BANANA BORER.

In a long memorandum, dated 7th April, 1917, the Commissioner of Agriculture for the West Indies, SIR FRANCIS WATTS, expresses the opinion that the black weevil borer of bananas (*Cosmopolites sordidus*) while capable of creating a certain amount of trouble in banana fields can be prevented from becoming a grave menace to the banana industry by careful cultivation. Under ordinary circumstances the attack of the weevil is directed to the bulb of the plant, eggs being laid on the surface of the bulb, below the ground-level,* the larvæ penetrating into the bulb, where the life-cycle is completed, the whole cycle taking about a month. Observations and records all tend to show that those parts of the bulb are attacked where the tissues from some cause lack vitality. In every banana plants there is the old bulb present, the fruiting bulb and the sucker, and in almost every case of infestation the old bulbs, which are in a dying condition, are attacked, while there is little tendency for the grubs to penetrate into the more vigorous or actively growing bulb.† In badly infested districts under examination, the bananas were found to be in a badly neglected condition and infested with the fungus. *Marasmius semiustus;* in these circumstances the weevil attacks are much deeper and more extensive than in healthier districts, and even here the bulbs were generally attacked at the base. It is suggested that experiments should be made in a weevil-infested area, small plots being planted and thoroughly manured and cultivated against disease or injurious influences other than the borer, when it is hoped that marked resistance would be shown to weevil attack. Attention is drawn to the fact that the allied weevil, *Metamasius* (*Sphenophorus*) *sericeus*, which is found on bananas, was supposed to be a direct pest of sugarcane, but careful investigation showed that the insect only attacks unhealthy and previously injured cane-tissue. In cases of deep-seated infestation of the bulbs, which will generally be found accompanied by *Marasmius* and imperfect cultural methods, it would be well to eradicate the bananas, which could be done under the advice of agricultural instructors. The destruction of the bulb-tissue would seem in that case to be of primary importance; this is probably best accomplished by cutting down and slicing up the stems in the usual manner and then digging up and slicing the bulbs, the slices being spread over the ground and stirred at intervals to promote decay. Eggs will probably be laid for preference on these slices, which must be cut the right thickness so that they will have decayed before mature weevil can develop in them. The insects might be attracted in such numbers as to make hand-collection advantageous. Growers should be careful to select only healthy planting material. The suggestion has been made that immersing banana bulbs in water for about 36 hours will kill all weevils present. If this simple remedy proves efficacious, growers should adopt the precaution. More knowledge is required concerning the natural enemies of the borer in Jamaica. The question of introducing a Histerid beetle from Java as a control is also being considered. Problems of dissemination of the pest and alternative host-plants also need elucidating. The views expressed in this memorandum are put forward tentatively and experimental evidence is desired before they can be regarded as conclusive.—THE REVIEW OF APPLIED ENTOMOLOGY, Series A., Vol. V., Pt. 10., Oct. 1917.

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* Other observers state that eggs are usually laid in the stem several inches above the soil. —ED.

† In the Congo, where this weevil has recently appeared and has destroyed considerable areas of bananas, M. MAYNE found that it was the young plants that were chiefly attacked. (See this *Review*, Series A,, v. p. 364).—ED.

COMPOSITION & PROPERTIES OF BUTTER.

C. M. ECKLES AND L. S. PALMER.

For many years research work has been carried out at the Missouri Agricultural Experiment Station on the influence of various foodstuffs on the composition of milk and butter. Recently, a new series of experiments has been started on cottonseed products, in order to explain, if possible, the varied and inconsistent results obtained on this subject by other investigators. These experiments have shown that the roughage which forms the base of the ration is the real factor in the effect of cottonseed products on the composition and properties of butter. The amount of cottonseed products fed, particularly the quantity of cottonseed oil they contain, is also important.

Concerning the character of the roughage, the data obtained show convincingly that with certain roughages, such as timothy hay and corn stover, (dried maize stems with cobs removed), timothy hay alone, alfalfa hay alone or cottonseed hulls, very marked effects on the composition and properties of butter accompany the feeding of cottonseed products, in some cases even in moderate amount. On the other hand, certain roughages, particularly corn silage, so counteract the effects of cottonseed products that moderate quantities, e.g., 3 or 4 lb. of meal, in some cases even as much as 6 lb. may be fed daily without lowering the quality of the butter or changing appreciably the composition of the fat.

This paper includes : (1) an historical part, with a chronological bibliography on the subject studied and 4 tables of numerical data ; (2) an experimental part illustrated by 12 tables of analytical data.

The results obtained led to the following conclusions :—

(1) The feeding of cottonseed produces characteristic effects upon the physical and chemical constants of butter fat and upon the properties of butter. These are manifested, in general, by a decrease in the saponification value and REICHERT-MEISSL number, and an increase in the iodine absorption value and the melting point of the butter fat. The effects on the butter are to cause a firmer body, frequently a gummy consistency, a higher standing up quality or ability to withstand a higher temperature without losing its body, a flat, oily taste, and a better keeping quality.

(2) The effects of feeding cottonseed products in the directions indicated are due largely if not entirely, to the amount of cottonseed oil which they contain.

(3) The extent of these effects is largely modified by the character of the raw foodstuffs which form the base of the ration. The effects are more marked when cottonseed products are fed with dry roughage, but less so if a fairly large amount of corn silage is given, as, in this case, the effects are sometimes neutralised. Further experiments are in progress to determine whether other roughages have similar properties.

(4) Small amounts of cottonseed products may be fed to cows on fresh pasture with very beneficial effects upon the body and keeping qualities of the butter.

(5) The effects of feeding cottonseed meal upon certain of the constants of the butter fat, particularly the REICHERT-MEISSL number and iodine value, may be somewhat modified by continuous feeding. The effects of the melting point of the fat and the other properties of the butter continue, however, as long as the cottonseed meal is fed.

(6) The feeding of large quantities of cottonseed meal and whole cottonseed as still practised in many localities in the South must be considerably modified if the butter industry of that part of the country is to attain its proper place in the butter industry of the nation. The use of the whole seed as a feed for dairy cattle is to be strongly discouraged on account of its excessive oil content.—BULL. INTERNAT. INST. OF AGRI., YEAR VIII—NUMBER 7, JULY 1917.

GARDENS IN WAR TIME.

The following suggestions have been drawn up with a view to helping those who are inexperienced in gardening:—

Vegetables should be grown instead of flowers, or at most only a small part should be devoted to flowers.

A small part of the garden, a warm corner well drained but not heavily manured, should be set aside for the purpose of seed saving.

Sow in this garden say, one dozen or more seeds of each of the following:—Scarlet runners, dwarf beans and haricot beans. Scarlet runners may be grown without stakes or poles. Sow the seed 2 ft. apart each way, and as soon as the point (the curling tip which makes the twining stem) is visible, pinch it out and similarly pinch out any branches which later on show signs of running. Do not pick any of the pods for eating purposes. When the pods are thoroughly ripe and beginning to turn yellow, pull up the plants and hang them in bundles in a warm, dry place. As soon as the pods are thoroughly dry they may be shelled, any bad seeds thrown away, and the good seeds spread on sheets of brown paper in a warm (but not hot), dry place. As soon as the pods are thoroughly dry they should be placed in paper bags or in seed packets, and kept in a cool, dry room.

To test germination of seed to be sown, place moistened, but not wet pieces of flannel or blotting paper in two saucers. Place in one of the saucers 20 or more seeds which have been soaked in water overnight. Cover the saucer containing the seed with the other and place it in a warm room, taking care, however, that the flannel or other material does not get dry. Inspect daily, and as soon as a seed shows its root remove it and after a time, varying according to the different seeds from a week or a fortnight, work out the precentage of germination. If the sample seeds have germinated well the remainder should be kept for next year.

Seed left over from last year should be tested and used in preference to this year's seed if it germinated fairly well.

All gardeners should exercise economy in seed sowing. Many gardeners sow seed too thickly. Seed is precious now and no more should be sown than is necessary. Before sowing, the number of plants required for the ground may usefully be estimated. A good rule is to sow no more than twice as many seeds as the number of plants required, although in the case of seeds which do not long retain their powers of germination (parsnips for instance), rather more should be sown.

Seed liable to be eaten by mice or birds should be moistened, rubbed in powdered red lead (a poison), and then planted.

Late summer sowing should be practised, and a good breadth of garden beet should be sown in the latter part of July or at the beginning of August, for winter use.

Onions and carrots should not be sown on freshly turned-up land.

Soot or lime dusted along the rows will help to keep down slugs.

Strands of black cotton stretched along the rows will protect seedlings from birds.

The tips of broad beans should be pinched out when the plants are about 2 ft. high in order to lessen the effect of attack by aphis (black fly).

If space is limited and it is desired to use a lawn without destroying the grass, turves 1 ft. square may be taken out at intervals of 3 ft. The ground should be broken up with a fork, a little well-rotted manure added, and the surface raked, after which climbing French beans may be sown. When the seedlings appear, they should be staked. After the crop is gathered the turves may be replaced (these should have been laid in any convenient part of the garden), and in a month or two the lawn will be as good as ever.—

JOURNAL OF THE BOARD OF AGRICULTURE, MAY, 1917.

SOME OBSERVATIONS ON THE OCCURRENCE OF INFERTILITY UNDER TREES IN INDIA.

JATINDRA NATH SEN.

It is well known that trees often give rise to the formation of infertile patches round themselves. The theory of shade which is usually adduced does not wholly explain the phenomenon. In the first place the affected tract of land does not always coincide with the shade-limit and secondly, lands under bamboos are known to remain infertile even after the removal of the clumps—the source of obstruction of the sun's rays.

Pot experiments with plants grown in soil taken from under a tamarind tree showed that the "tamarind" soil contained something which was evidently positively harmful to plant growth. In this case, the trouble was found to be due to the accumulation of an excessive amount of soluble salts, but this is not invariably so. The nature of the salts is also of importance, some salts being more toxic than others.

This accumulation of soluble salts might be due partly to the leaching out of the mineral matter in the dead remains of the plant (decayed roots and fallen leaves) but transpiration of the plant is likely to be an important factor. A growing tree transpires an enormous amount of water. The roots have to abstract this water from the soil particles with which they come in contact. On account of the soil near about the roots thus getting drier than the rest of the mass of soil, there sets up a movement of water from the wetter to the drier zone to restore the equilibrium. This movement goes on continuously with the growth of the tree. Alone with the water, the dissolved salts present in the soil solution also move towards the tree.

On this assumption plants having a high transpiration ratio would produce harmful results quickly. It may be that plants having thin or small leaves—tamarind, "pipal" *(Ficus religiosa)*—transpire relatively more water than trees having thick leaves—"bar" *(Ficus bengalensis)*. The extent and distribution of the root-system are also of importance. Plants having a smaller root-range relatively to the transpiration would, of course, effect a greater local concentration of salts. Again, the injurious effect may be apparent soon if the roots are mostly in the top layers of soil.

These considerations might probably hold in the case of bamboos. Other factors are competition for sunlight and plant food and inability to get rid of some of the injurious products of the vital activities of the plant (including carbonic acid) sufficiently rapidly.

With regard to remedies in such cases of infertility, the removal of the trees is the first step. After this attempts should be made to effect a permanent improvement in the texture of the soil by means of deep cultivation and the addition of organic manures. Proper drainage facilities should be provided so that the salts may readily pass out of the soil. In some cases it may be necessary to have recourse to an efficient system of irrigation (combined with suitable drainage) to get rid of the accumulated salts.—BULL. INTERNAT. INST. OF AGRICULTURE, Oct. 1917.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED 31st JANUARY, 1918.

Province.	Disease	No. of cases to date since Jan. 1st. 1918.	Fresh cases	Recoveries.	Deaths.	Balance ill.	No. shot.
Western	Rinderpest	14	—	5	9	—	—
	Foot & mouth disease	3	—	3	—	—	—
Colombo Municipality	Rinderpest	—	—	—	—	—	—
	Foot & mouth disease	2	—	—	—	—	—
Quarantine Station	—	—	—	—	—	—	—
Central ...	Foot & mouth disease	14		12	—	2	—
Northern	—	—	—	—	—	—	—
North-Western	Rinderpest	7	—	—	4	3	—
	Foot & mouth disease	7	—	3	—	4	—
Eastern	Foot & mouth disease	115		65	1	49	—
Sabaragamuwa	—	—	—	—	—	—	—
Uva	Foot & mouth disease	8	—	5	—	3	—
North-Central	Foot & mouth disease	Foot & mouth disease exists largely	Correct figures are not to hand				
Southern	—	—	—	—	—	—	—

G. W. STURGESS, G.V.S.

METEOROLOGICAL.

JANUARY, 1918.

Station.	Temperature: Mean Daily Shade	Temperature: Difference from average	Mean Humidity	Mean amount of cloud 0=clear. 10=Overcast	Mean Wind direction during month	Daily mean Velocity	Rainfall: Amount	Rainfall: No. of Rainy days	Rainfall: Difference from average
	°	°	%			Miles	Inches		Inches
Colombo Observatory	77 5	-1·5	80	6·2	NNW	119	4·25	10	+1·16
Puttalam	75·9	-1·4	87	5·4	NNE	101	7·67	15	+5 30
Mannar	78·1	-0·7	78	7·4	NNE	202	8·94	13	+6·57
Jaffna	77·1	-0·3	82	5·4	NE	122	5·06	12	+2·95
Trinco'mee	76·8	-1·9	86	7·4	NE	179	13·49	20	+7·62
Batticaloa	77·0	-0·8	83	6·8	NNE	143	15·49	18	+5·74
Hambantota	76·6	-1·9	86	5·7	ENE	241	4·91	12	+1·54
Galle	77·1	-1·3	83	7·4	Variable	106	5·30	13	+0 96
Ratnapura	77·8	-2·0	78	6·7	—	—	4·67	14	-0·42
Anu'pura	76·4	-0·2	82	8·2	—	—	12·77	18	+9·49
Kurunegala	76·6	-1·6	74	7·6	—	—	5·32	14	+2·07
Kandy	73·6	-0·8	74	7·2	—	—	5·23	15	+0·25
Badulla	69·2	-1·0	82	7 6	—	—	9·20	20	-0·47
Diyatalawa	64·0	-0.6	80	8·4	—	—	6·23	17	+0·13
Hakgala	57·0	+0·1	88	8·1	—	—	11·51	23	+2·01
N'Eliya	57·6	+0·5	80	7·5	—	—	6·38	15	+0·72

The weather for January was somewhat unsettled and only at the commencement of the month, a few day's in the third week and the last few days was it fine over the whole of the Island.

For the greater part of the Island the rainfall was above normal. The districts in which less than usual was experienced were, roughly, the extreme Southeast, Uva and the South and Southwest slopes of the Hills.

The temperature, on the whole, was in deficit and at times this deficit was very marked.

Humidity and the clouded state of the sky were in excess of normal.

Over the Island as a whole, the wind both in strength and direction was much about that of the average.

J. E. EVANS,
Acting Supdt, Observatory.

MARKET RATES FOR TROPICAL PRODUCTS.

(From Lewis & Peat's Latest Monthly Prices Current.)

	QUALITY.	Quotations.
ALOES, Soccotrine cwt.	Fair to fine	95/ a 100/
Zanzibar & Hepatic ,,	Common to good	40/ a 105/
ARROWROOT (Natal) lb.	Fair to fine	7d a 8d
BEES' WAX cwt.		
Zanzibar Yellow ,,	Slightly drossy to good	£9 10/ a £9 15/
East Indian bleached ,,	Fair to good	£11 12/6 a £12
,, unbleached ,,	Dark to good genuine	£9 a £9 10/
Madagascar ,,	Dark to good palish	£9 5/ a £9 15/
CAMPHOR, Japan lb.	Refined	3/6 a 4/3
China cwt.	Fair average quality	Nominal
CARDAMOMS, Tuticorin	Good to fine bold	3/6 a 4/6 nom.
per lb.	Middling lean	2/ a 2/9 ,,
Malabar, Tellicherry ,,	Good to fine bold	3/ a 4/ ,,
Calicut ,,	Brownish	1/9 a 2/6 ,,
Mangalore ,,	Med Brown to good bold	2/6 a 5/3 ,,
Ceylon, Mysore ,,	Small fair to fine plump	2/ a 5/
Malabar ,,	Fair to good	1/7 a 1/8
Seeds, E. I. & Ceylon ,,	Fair to good	2/ a 2/3
Ceylon "Long Wild" ,,	Shelly to good	1/ a 1/6 nom
CHILLIES, Zanzibar cwt.	Dull to fine bright	75/ a 85/
Japan ,,	Fair bright small	60/ a 70/
CINCHONA BARK.—lb.	Crown, Renewed	3⅜d a 7d
Ceylon	Org. Stem	2d a 6d
	Red Org. Stem	1¾d a 4¼d
	Renewed	3d a 5¼d
	Root	1⅞d a 4d
CINNAMON, Ceylon 1sts.	Fair to stout quill	2/6
per lb. 2nds.	,, ,,	2/3
3rds.	,, ,,	2/
4ths.	,, ,,	11d
Chips,	Fair to fine bold	10½d a 1/
CLOVES, Penang lb.	Dull to fine bright pkd.	3/6 a 4/
Amboyna ,,	Dull to fine	2/ a 2/6
Zanzibar ,,	Fair and fine bright	1/9 a 1/10
Madagascar ,,	Fair	1/9 a 1/10
Stems ,,	Fair	7½d
COFFEE		
Ceylon Plantation cwt.	Medium to bold	Nominal
Liberian ,,	Fair to bold	,,
COCOA, Ceylon Plant. ,,	Special Marks	87/ a 90/
	Red to good	80/ a 88/
Native Estate ,,	Ordinary to red	50/ a 76/
Java ,,	Small to good red	70/ a 96/
COLOMBO ROOT ,,	Middling to good	100/ a 120/
CROTON SEEDS, sifted ,,	Dull to fair	70/ a 75/
CUBEBS ,,	Ord. stalky to good	£16/ a £18/
FIBRE, Kitul lb.	OOO good long	10d a 11d
	OO ,, medium	8½d
	No. 1 fair	7d
Palmyrah ton.	Common to fair	£30/ a £35 nom.
,,	Medium to good med	£40/ a £45 ,,
	Good to fine	£50/ a £60 ,,
GINGER, Bengal, rough cwt.	Fair	62/6
Calicut, Cut A ,,	Medium to fine bold	100/ a 110/
B & C ,,	Small and medium	90/ a 100
Cochin, Rough ,,	Common to fine bold	67/6 a 72/6
	Small and D's	67/6
Japan ,,	Unsplit	50/ a 52/6
GUM Ammoniacum ,,	Ord. blocky to fair clean	175/ a 200 nom.
Animi, Zanzibar	Pale and amber, str. srts	£14 10/a £16 10/
,,	,, ,, little red	£11 a £12
,,	Bean and Pea size ditto	70/ a £11
,,	Fair to good red sorts	£8 10/ a £10 10/
,,	Med. and bold glassy sorts	£5 10/ a £7 5/
Madagascar ,,	Fair to good palish	£4 a £8
,,	,, ,, red	£4 a £7
Arabic, E. I. & Aden ,,	Ordinary to good pale	55/ a 75/
Turkey sorts ,,	... ...	85/ a 87/6
Ghatti ,,	Sorts to fine pale	30/ a 50/
Kurrachee ,,	Reddish to good pale	35/ a 50/ nom.
Madras ,,	Dark to fine pale	30/ a 45/ nom.
Assafœtida ,,	Clean fr. to gd. almonds	£15 a £20
	com. stony to good block	£4 a £10
INDIGO, E.I. Bengal lb.	Shipping mid to gd. violet	10/ a 13/
,,	Consuming mid. to gd.	9/ a 10/
,,	Ordinary to middling	8/6 a 9/6
,,	Mid. to fine Kurpah	7/ a 9/
,,	Low to ordinary	5/ a 6/9
,,	Mid. to fine Madras	2/6 a 4/6
KAPOK-Ceylon lb.	Ordinary to good	1/ a 1/4
KINO lb.	Fair to fine bright	6d a 1/5
MYRRH, Aden sorts cwt.	Middling to good	170/ a 200/
Somali ,,	,, ,,	140/ a 160/
MACE, Bombay & Penang per lb.	Pale reddish to fine	3/6 a 4/
	Ordinary to fair	3/ a 3/6
Java ,,	,, good pale	3/6 a 4/
Bombay	Wild	8d

	QUALITY.	Quotations.
NUTMEGS,— lb.		
Singapore & Penang ,,	64's to 57's	2/ a 2/6
	80's	1/11
	110's	1/6
NUX VOMICA, Cochin	Ordinary to good	42/6 a 45/
per cwt. Bengal	,, ,,	35/ a 40/
Madras	,, ,,	37/6 a 42/6
OIL OF ANISEED lb.	Fair merchantable	4/3
CASSIA ,,	According to analysis	6/ a 6/3
LEMONGRASS oz.	Good flavour & colour	5d
NUTMEG ,,	Dingy to white	1½d a 1¾d
CINNAMON (Ceylon)	Ordinary to fair sweet	6d a 2s
CITRONELLE ,, lb.	Bright & good flavour	2/4
OLIBANUM, drop cwt	Good to fine white	130/ a 150/
,,	Middling to fair	100/ a 120
pickings ,,	Low to good pale	22/6 a 40/
siftings ,,	Slightly foul to fine	35/ a 45/
ORCHELLA WEED—cwt		
Ceylon ,,	Fair	10/6
Madagascar ,,	Fair	10/6
Zanzibar ,,	Fair	10/6
PEPPER—(Black) lb.		
Alleppy & Tellicherry	Fair	1/3 a 1/3½
Ceylon ,, ,,	Fair to fine bold heavy	1/2 a 1/4
Singapore ...	Fair	1/2¾
Acheen & W. C. Penang	Dull to fine	1/2
(White) Singapore ,,	Fair to fine	1/8
Siam ,,	Fair	1/8½
Penang ,,	Fair	none
Muntok ,,	Fair	1/8½
RHUBARB, Shenzi ,,	Ordinary to good	1/4 a 3/
Canton ,,	Ordinary to good	1/3 a 2/6
High Dried ,,	Fair to fine flat	1/7 a 1/9
RUBBER, INDIA lb.	Standard smoked sheets	2/4½
Ceylon, Straits, ,,	Standard Crepe	2/5½
Malay Straits, etc. ,,	Scrap fair to fine	1/8
Assam ,,	Fair 11 to ord. red No. 1.	1/4
Rangoon ,,	,, ,, ,,	1/6
Borneo ,,	Common to good	1/6
Java ,,	Good to fine red	1/8 a 1/10
Penang ,,	Low white to prime red	1/6 a 1/9
Mozambique ,,	Sausage, fair to good	1/6 a 2/
Nyassaland ,,	Fair to fine ball	1/6 a 2/
Madagascar ,,	Fr. to fine pinky & white	1/4 a 1/7
,,	Majunga & blk coated	1/
,,	Niggers, low to good	9d a 1/6
New Guinea ,,	Ordinary to fine ball	1/6 a 2/
SAGO, PEARL, large--cwt	Fair to fine	50/ a 65/
medium ...	,, ,,	50/ a 65/
small ...	,, ,,	50/ a 65/
Flour ...	Good pinky to white	40 a 77/6
SEEDLAC cwt.	Ordinary to gd. soluble	225/ a 250/ nom.
SENNA, Tinnevelly lb.	Good to fine bold green	10d a 11d
	Fair greenish	6½d a 9d
	Common specky & small	3½d a 5½d
SHELLS, M. of PEARL—		
Egyptian cwt.	Small to bold	40/ a £5 10/ nom
Bombay ,,	,, ,,	55/ a £5 15/ ,,
Mergui ,,	Chicken to bold	£6 15/ a £10 15/
Manilla ,,	,, ,,	£6 a £10/ nom
Banda ,,	Sorts	40/ a 45/ ,,
Green Snail ,,	Small to large	50/ a 75/ ,,
TAMARINDS, Calcutta...	Mid to fine bl'k not stony	45/ a 50/
per cwt. Madras	Inferior to good	25/ a 35/
TORTOISE SHELL—		
Zanzibar & Bombay lb.	Small to bold	10/ a 25/
	Pickings	5/ a 15/
Ceylon	Small to bold	10/ a 22/
Mauritius & Seychelles	,, ,,	10/ a 25/
TURMERIC, Bengal cwt.	Fair	50/
Madras ,,	Finger fair to fine bold	55 a 60/
Do. ,,	Bulbs ,, ,, bright	45/ nom.
Cochin ,,	Finger fair	50/ nom.
	Bulbs ,,	37/6
VANILLA.— lb.		
Mauritius ... 1sts.	Gd. crystallized 3½a 8½ in.	5/6 a 9/6
Madagascar ... 2nds.	Foxy & reddish 3½a ,,	5/ a 7/
Seychelles ... 3rds	Lean and inferior	5/ a 5/9
WAX, Japan, squares, cwt.	Good white hard	92/6